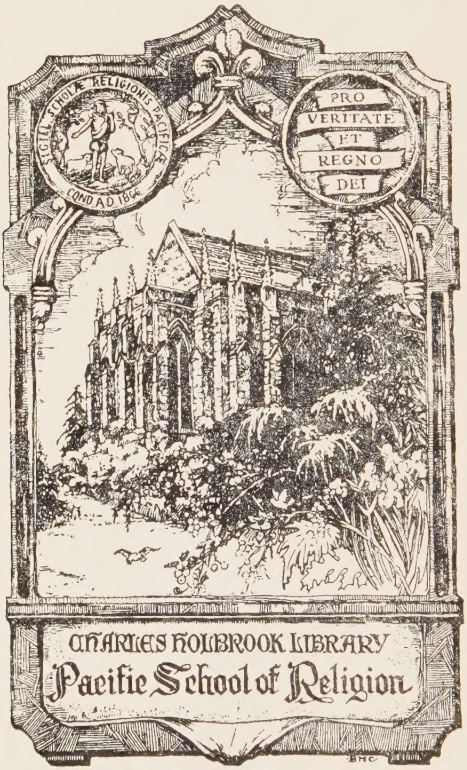
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OF

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*LONDON:*

Printed for GEORGE STRAHAN at the *Golden-Ball* in *Cornhil*, over against the *Royal-Exchange*. MDCCXV.

57677

To His GRACE

# JOHN,

## DUKE of *ROXBURGH*,

Marqueſs of *Bowmont* and *Ceſsford*, Earle of *Kelſo*, Viſcount of *Broxmouth*, Baron *Ker* of *Ceſsford*, and *Cavertoun*, &c.

Keeper of His MAJESTIES Great Seal, in *Scotland.*

May it pleaſe your GRACE,

*S you condeſcended to do me the Honour to ſuffer your* Name *to be prefix'd to the former Edition of this Work: So I humbly Hope,* Your Grace *will continue the ſame Goodneſs, to this more full and correct One. I ſo deeply and juſtly Honour* Your Grace, *that, as I am ſure you do not expect, ſo I own I dare not beſtow, the Compliments uſual in Addreſſes of this Kind. That* Your Grace *may Live an* Example

Example *of* Solid Virtue, *in your High Rank here, and may be* Crowned with an exceeding Weight of Glory *hereafter, is the Earneſt* Prayer, *of*

May it pleaſe your Grace,

Your Grace's

moſt oblig'd

moſt Faithful,

moſt humble Servant,

GEO. CHEYNE.

# PHILOSOPHICAL PRINCIPLES OF Natural Religion.

## PART I.

Containing the

# ELEMENTS OF *Natural Philoſophy,*

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# THE PREFACE

## To the first Part.

Had not given the World any further Trouble with my poor Labours on such uncertain and *intricate* Subjects as are here treated of, had I not been often Sollicited to give orders for another *Edition* of this Work, for the Use of the Younger Students of *Philosophy*, who while they were taught the most probable account of the *Appearances of Nature* from the Modern Discoveries, might thereby have the *Principles* of *Natural Religion* insensibly instill'd into them at the same time. This, with the Consent and Approbation of those, whose Advice will be always sacred with me, were the Principal Motives to this *Edition*; and while it was under Hands,

I was inclined to have it as correct and full, as the Animadverſions and Corrections of thoſe *Friends*, who were capable and willing to undertake them; my own low Abilities, uncertain Health, and neceſſary Avocations wou'd permit.

I had ſeen the Obſervations and Corrections, the *late Ingenious and Learned* Dr. *Gregory*, *Savilian Profeſſor of Aſtronomy*, at *Oxford*, had made on the former *Edition* of this part. I had ſome Remarks from the *Reverend and Learned* Mr. *John Craig*; as alſo ſome very Judicious Reflections from a *Gentleman at Cambridge* who conceals his Name. Theſe I freely uſed, with the beſt Judgment and utmoſt Application I was capable of, to make the Corrections and Emendations of this Part now again Publiſhed. As to the Additions, beſides what my own Reflections ſuggeſted, the principal ones were taken from the Second Editions of Sir *Iſaac Newton's* (*that great Inventor and Improver of moſt of our Modern Philoſophy* and *Geometry*) his *Opticks* and *Mathematical Principles*

*ciples of Philosophy*; Mr. *Cotes*, (*the Learned Plumian Professor of Astronomy at Cambridge*) his Preface to that Edition; the *Reverend and Learned* Mr. *Derham's two late Pieces*; *the Philosophical Transactions*, and *the Memoirs of the Academy Royal at* Paris. I Intended to have had these Alterations and Additions printed by themselves, for the Benefit of those who had the first Edition, but I found it was impracticable.

I am very Sensible, the best accounts of the Appearances of Nature (in any single Instance how minute or simple soever) Humane Penetration can reach, comes infinitely short of its reality, and internal Constitution; for *who can search out the Almighty, or his works to Perfection.* Some of the grosser Out-lines and prominent Lineaments of Nature, are as near, as is allowed to Mortals to approach. But this I think I may venture to say, that *Atheism*, may be Eternally confounded, by the most distant Approaches to the true causes of Natural

Natural Appearances. And that if the *Modern Philosophy* demonstrates nothing else, yet it infallibly proves *Atheism* to be the most gross Ignorance.

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*Philosophical*

# *Philosophical Principles* OF RELIGION.

## PART I.

### CHAP. I.

### *Of the Physical* LAWS *of* NATURE.

§ I. THERE is nothing a more common Subject of Discourse than *Nature* and its *Laws*; and yet, however Use has made these Words familiar, there are few that agree in their Notions about them: The Reason of which seems to be, that these Terms imply *Notions* so compounded, and so far re-

mov'd from the Knowledge of most Men, that there are scarce any that distinctly conceive all the Simple *Ideas* that enter their Composition; I shall not pretend to settle the Signification of these Words in their utmost extent (That being perhaps above the power of Human Faculties in this *Lapsed* estate) it will be enough to my present purpose, to give the Sense I shall apply to them in the following Discourse.

§ II. By *Nature*, I understand this vast, if not infinite *Machin* of the *Universe*, the Perfect and Wise Production of Almighty God, consisting of an infinite Number of lesser *Machins*, every one of which is adjusted by Weight and Measure. By the *Laws* of *Nature*, I mean, those Laws of Motion, by which natural Bodies are commonly govern'd in all their Actions upon one another, and which they inviolably observe in all the Changes that happen in the natural State of things. But here we are to distinguish between the Laws of *Creation* and those of *Nature*, for not only the great Bodies of this Universe, but the inferiour *Machins* thereof, were formed by a different Law from what they are now govern'd. For none of the *Laws* of *Motion* or *Nature* now establish'd, will any way serve to account for the *Production*, *Figure*, *Size*, *Motion* or *Number* of the *Great Bodies* of the Universe, nor of their *Appendages*, tho' they may help us a little to conceive their *Appearances*, now they are Created, and put in regular and beautiful Motions:

Motions. But this will be more distinctly explain'd afterwards.

§ III. That there is no such thing as an *Universal Created Soul* animating this vast System according to *Plato*, nor any *Substantial Forms* according to *Aristotle*, nor any Omniscient *Radical Heat* according to *Hippocrates*, nor any *Plastick Virtue* according to *Scaliger*, nor any *Hylarchic Principle* according to *Henry Moor*, is evident from the following Considerations; 1. These (as they are now generally understood, tho' perhaps a just and true Sense might be put upon them) are meer *Allegorical* Terms coin'd on purpose to conceal their Author's Ignorance When some *Philosophers* cou'd not account for the appearances of Nature, they were so far from owning any want of Knowledge, that to keep up their Credit with the thoughtless and credulous part of Mankind, they attributed these unaccountable Effects, to unintelligible Beings of their own Contrivance, which neither had Foundation nor Existence in Nature: But whoever will give themselves the least trouble to consider the Matter, will plainly see, that they really meant nothing by those amazing Terms, but to disguise their own Ignorance. 2. These deputed Beings (as they are commonly understood) are derogatory from the Wisdom and Power of the *Author* of *Nature*, who doubtless can govern

this *Machin* he cou'd create, by more direct and eaſie Methods, than employing theſe ſubſervient *Divinities*. 3. The Appearances themſelves, to ſalve which they were contriv'd, may be by more intelligible and leſs indirect Principles accounted for, as in ſome meaſure ſhall be afterwards ſhown. And Beings are not to be multiply'd without a plain Neceſſity. 4. Laſtly, Theſe very *Beings* will not ſerve the deſign of their Creation, unleſs we endow 'em with Powers and Faculties above the Dignity allow'd by their *Authors*, to ſuch ſecondary Agents.

I do not here intend, to inſinuate any thing againſt the Miniſtry of *Angels*, or the Adminiſtration of *Subordinate Spirits* in the *All-Wiſe*'s Government of the World, and in the Works of his Providenee: on the contrary, I think *that* more certain, than any thing in our Philoſophy, diſcoverable by the meer uſe of Human Faculties can be, ſince even moſt of thoſe *Appearances* which we account for from our Philoſophick Principles, may, for ought we are abſolutely certain to the contrary, be owing to them. But as we are not to have recourſe to *their* Agency, without plain Neceſſity, ſo *they* were never intended by the Inventers of theſe *Secondary Agents* I have been now diſproving: on the contrary, by theſe, as they are commonly underſtood, are meant ſome Lifeleſs, Independent, Fanciful Powers, Principles, or Faculties unintelligible in true *Philoſophy*, and inconſiſtent

ſiſtent with reveal'd Religion, though perhaps an Explanation may be made of them *congruous* to both.

§ IV. The *Scheme* of *Nature* which ſeems moſt agreeable to the Wiſdom of its Author, according to the modern Diſcoveries, is (ſuppoſing the *Syſtem of the Univerſe* already created) that he has ſettled Laws, and laid down Rules, conformable to which natural Bodies are govern'd in their Actions upon one another, and according to which, the Changes in the material part of this *Syſtem* are brought about, which all Bodies inviolably obſerve, and which of themſelves naturally acting, they never tranſgreſs in the leaſt degree, whilſt *God Almighty* by his *intimate* Preſence, in, and with every ſingle part of the Univerſe, preſerves them in their Faculties and Operations. All the *Integral* Parts of *Nature*, have a beautiful *Reſemblance*, *Similitude*, and *Analogy* to one another, and to their Almighty *Original*, whoſe Images, more or leſs expreſſive according to their ſeveral Orders and Gradations, in the *Scale* of Beings, they are; and they who are Maſters in the noble Art of juſt *Analogy*, may from a tolerable Knowledge in any one of the *Integral* Parts of Nature, extend their Contemplations more ſecurely to the whole or any other *Integral* Part leſs known. Thus this great *Machine* of the Univerſe has a Reſemblance to the leſſer One of a *humane Creature*; for, as in the laſt, the vital Functions are per-

form'd by general and constant Laws; the *Food* is concocted, the *Heart* beats, the *Blood* circulates, the *Lungs* play, the *Secretions* are made by the Laws of Motion, and the constant Rules of *Action* of the lesser Bodies upon one another; So the great Bodies in the several *Systems* of the Universe, move in their *Orbits*, turn about their *Axes*, and act upon one another according to the establish'd Laws of Motion, and the great Principles of Activity, of these greater Bodies upon one another. Again, as the *spiritual* Part of the humane Compound, is intimately present with, presides over, actuates and enlivens the whole and each Part of the Body, so the *Infinite Creator* and *Governour* of the *Universe*, is co-extended with infinite Space, is intimately present with every single Point of its Dimensions, presides over the Whole and all its Parts, maintains their Being and their first impress *Energy*. The *Analogy* might be carried to many, and much more sublime Speculations, but these are sufficient for my present Purpose, which is to shew in the following Sheets, according to my poor Abilities, that the best and most satisfactory Explications of the *Appearances* of Nature hitherto discovered, do all evince the necessary *Being* and special *Providence* of God *Blessed for ever.*

§ V. It is not my Design here to explain all the particular *Laws of Motion*, and of the Actions of Bodies upon one another, nor cou'd it

be

be well done in ſo narrow a Compaſs as I have propoſed to my ſelf; I ſhall here only ſet down the General *Laws of Nature*, which virtually include theſe others, and infer ſuch Concluſions from 'em as I find moſt neceſſary for clearing ſome parts of the following Diſcourſes.

## LAW I.

ALL Bodies perſevere in the ſame State of Reſt, or of moving forward in a ſtrait Line, unleſs forc'd out of that State by ſome outward impreſt Violence, *that is*, all Bodies at reſt will naturally, and of themſelves for ever continue in Reſt, unleſs ſome external Cauſe put 'em in Motion: And all Bodies in motion will naturally move forwards for ever in the ſame ſtrait Line, unleſs they are ſtop'd by ſome oppoſite Force, or turn'd out of their Courſe by ſome differently directed Violence.

§ VI. To ſhew how inviolably this Law is obſerv'd by natural Agents, we need only conſider it never has been obſerv'd that any Body did of it ſelf bring it ſelf from Reſt to Motion, nor that ever any Body in Motion brought it ſelf to Reſt; Nor that ever any Body in Motion, of it ſelf altered its Courſe, but that whereever ſuch Changes happened, there were always evident Cauſes. If Bodies chang'd their places of themſelves, all Things wou'd run in-

to Confusion, nor wou'd there be any certain Means to regulate the *Motions* of the Universe. We are certain *Projectils* wou'd for ever move on in the same right Line, did not the Air, their own Gravity, or the Ruggedness of the Plane, on which they move, stop their Motion; or did not some Body with a different Direction alter their Course. A Top whose parts, by their Cohesion, hinder one anothers rectilinear Motions, wou'd never cease to turn round did not the Air gradually impair its Motion. Natural Bodies consist of a Mass of Matter, which by it self can never alter its State, and if Bodies are once at rest, they must continue so, unless some new Force put 'em in Motion. If in Motion, the same *Energy* will continue 'em in Motion and drive 'em forwards in the same Directions.

§ VII. Moreover, there is in Matter a passive *Principle*, which Sir *Isaac Newton* very well expresses by the *vis inertiæ*, whereby Bodies resist to the utmost of their Power, any change or alteration of their State, whatever it be, either of Rest, Motion, or its Direction; And this Resistance is always equal in the same Body, and in different Bodies is proportional to the quantity of Matter they contain. There is required as much Force to stop a Body in Motion, as is required to put it in Motion, and *è contra*; And therefore since the same Body equally resists the contrary equal Changes of its State,

State, this Reſiſtance will operate as powerfully to keep a Body in Motion as to keep it at Reſt, and conſequently of it ſelf, it can never change its State of Reſt, Motion, or Direction; for to change its Direction, is the ſame thing as to move of it ſelf another way. Matter then of it ſelf is ſo far indifferent to Motion or Reſt, that it is no more inclin'd to the one than to the other, and does no leſs Reſiſt a change from Reſt to Motion, than from Motion to Reſt. This *vis inertiæ* is no where more conſpicuous than in the ſudden Motion of a Veſſel full of Liquor upon a Horizontal Plane, at firſt while the Veſſel is moving along the Plane, the Liquor ſeems to move with a Direction contrary to that of the Veſſel, the Water riſing on the hinder ſide of the Veſſel. Not that there is really any ſuch Motion impreſs'd upon the Liquor, but that by the *vis inertiæ*, the Water endeavouring to continue in its State of Reſt, the Veſſel can't immediately communicate its Motion to it, by reaſon of its Bulk and fluid State; But the Liquor perſeveres in its State of Reſt, whilſt the Veſſel makes forwards and ſo ſeems to move a contrary way. But when once the Liquor has the Motion of the Veſſel intirely communicated to it, and begins to move with a Velocity equal to that of the Veſſel, if the Veſſel be ſuddenly ſtop'd, the Liquor continues its Motion and daſhes over the ſides of the Veſſel. This *Paſ-*

*ſive*

*sive* Principle or *vis inertiæ* is essential to Matter, because it neither can be depriv'd of it, nor intended or remitted in the same Body, but is always proportional to the quantity of Matter Bodies contain.

## *Corollary* 1.

§ VIII. Hence it is evident that no Particle of Matter, nor any Combination of Particles, *that is*, no Body, can either move of themselves, or of themselves alter the Direction of their Motion; Matter is not endow'd with Self-motion, nor with a Power to alter the Course in which it is put, it is meerly passive and must for ever of it self continue in that State and that Course that it is settled in; and if it can't move of it self, it can never alter its Course of it self when in Motion, for to alter its Course of it self, is only to move of it self after a particular manner.

## *Corollary* 2.

§ IX. Hence it is Evident, that no Body put in Motion will naturally, and of it self move in a *Curve Line*. All Motion is naturally forward in the same strait Line with the Direction of the moving Force; but what ever moves in a Curve Line must in every Point alter its Direction, and therefore naturally of it self, no body can move in a *Curve Line*. *Co-*

## *Corollary* 3.

§ X. Hence the great Bodies of this Univerſe the *Planets*, their *Satellits*, and the *Comets* do not naturally and of themſelves (tho' at firſt put in Motion) move in their reſpective Orbits, which are *Curve-Lines* returning into themſelves, but are kept in them by ſome attractive Force, which if once ſuſpended, they wou'd for ever run out in right Lines, and conſequently the Motions of theſe Great Bodies in their *Orbits* do abſolutely depend upon this attractive Force, whenceſoever it ariſes.

## *Corollary* 4.

§ XI. Hence neither Motion nor Reſt (I mean not one of 'em particularly) is eſſential to Matter, *i. e.* Matter is indifferent as to either of theſe particularly, and does as much reſiſt its being chang'd from Reſt to Motion, as it does the being chang'd from Motion to Reſt. And as any Force will imprint ſome degree of Motion on a *quieſcent* Body, ſo the ſame degree of Force impreſs'd at the ſame time with a contrary Direction, will bring it to Reſt again, but it is not neceſſary to the *Being* of Matter that it be in Reſt or Motion, for Matter will be ſtill Matter in which ever of theſe States it be. In a Word, ſince the formerly mentioned

paſſive

passive Principle or *vis inertiæ* is essential to Matter, it thereby becomes indifferent as to Motion or Rest, and is equally susceptible of either according as the extrinsic Force urges it.

## *Corollary* 5.

§ XII. Hence the Necessity of a *Vacuum*, or space distinct from Matter, is clearly demonstrable; for since by their *vis inertiæ*, all Bodies resist to the utmost of their Power, any Change or Alteration of their State, whether of Motion or Rest; and since the Resistance in the same Body is always equal, or the same, and in different Bodies is proportionable to the Quantity of Matter they contain; and since consequently, if two Bodies containing equal Quantities of Matter, and moving with equal Celerities in contrary Directions, so that they impinge directly upon one another, will certainly both rest or stop at the Point of their Concourse, as also since it is demonstrable, that two Bodies moving contrary wise with equal Celerities, and both resting at their meeting, are equally Heavy; it necessarily follows, that two Bodies containing equal Quantities of Matter, are equally Heavy, and therefore were there no Vacuities in Bodies, two Spheres of equal Diameters, should contain equal Quantities of Matter, and consequently be equally Heavy, *i. e.* two Spheres of equal *Diameters*

on

one of Gold, another of Wood, ſhou'd have the ſame ſpecifick Gravities, which being contrary to Experience, there is a Neceſſity of admitting Vacuities in the latter Sphere to anſwer the Difference of their Gravities.

It is true, it may be here anſwered, that one of the equal Bodies may be ſuppos'd to be more *poroſe* than the other, and the Pores to be pervaded by a ſubtle Fluid, which paſſing freely through the Bodies, is not concern'd in the *Impulſe*. And to obviate this Objection, and conſequently to make this proof of the Neceſſity of a *Vacuum* amount to a Demonſtration, Sir *Iſaac Newton* has ſhewn from many repeated Experiments by *Pendulums*, in Air, Water, and Mercury; and more exactly by Experiments on heavy Bodies falling in Air, and Water; that the *Reſiſtance* of Fluid Bodies is always proportional to their *Denſities*, that is to the Quantities of Matter they contain, or their *Vires Inertiæ*. The *Reſiſtance* in Fluids ariſes from their greater *Preſſing* on the Fore, than Hind part of the Bodies moving in them; and this muſt be always in all Fluids proportional to the Quantity of Matter they contain, which preſſes on theſe ſides, that is, their *Denſity*. Bodies moving in Fluids preſs upon and excite a Motion in the Fluids in their paſſage; and this Motion thus impreſſed ariſes from the exceſs of the *Preſſure* of the Fluid upon the fore-part, above that *Preſſure* on the hind-part of the moving Bodies; and this

this excess of *Pressure* of Bodies in Fluids, will not only raise a Motion in them, but will also act on the Bodies themselves, by retarding their Motion, according as it is greater or less, whence the *Resistances* of Fluids arise; wherefore the *Resistances* of Fluids, are as the Quantities of Matter they contain, or their *Densities*, which alone can make the Excess greater or lesser. It is true, there is a Resistance in Fluids which may arise from their *Elasticity*, *Glutinousness*, and the Friction of their Parts, *&c.* This *Resistance* may be lessend and in a great measure remov'd by the change of the Figure and Size of their Parts. But these Considerations have no place in any of the Fluids of our System, wherein Experiments have been made, it having been always found that their *Resistances* were proportional to their Densities. So that no *Subtilization*, *Division* of parts, or *Refining* can alter their *Resistances*, these depending intirely on their Densities or *Vires inertiæ*, that is, the Quantities of matter they contain; and the most Subtile *Æther* would give the same *Resistance* to a Projectile, as *Mercury*, if the Density or Quantity of matter were the same in the first as the last: for that being supposed, the Excess of the Pressure or Weight on the fore-part, above that on the hind-part of the *Projectile* would be the same in both, on which alone the Resistances of both depend. Since it is weight alone, that is matter, that can produce *Pressure* in inanimate Bodies.

*Vide*

*Vide Newton. Schol. Prop. XL. lib.* 11. 2*d. Edit.* From all which it is plain that if Bodies be ever ſo *Poroſe* and fill'd with Fluids ever ſo *Subtile*, yet if there be no *Vacuities* without matter intirely, theſe *Poroſe* Bodies muſt be equally heavy with the moſt compact ones, ſince the Fluids requir'd to fill theſe Pores muſt be equally heavy with the ſolid Body, ſince both muſt contain an equal Quantity of matter if there be no *Vacuities*, all Fluids reſiſting, that is indeed weighing, in proportion to the Quantities of matter they contain. If therefore there be no *Vacuities*, all Bodies muſt be equally heavy, which being contrary to Experience, there is a Neceſſity of admitting *Vacuities*, to account for the different Weights of Bodies.

## LAW II.

§ XIII. THE Changes made in the Motions of Bodies are always proportional to the impreſs'd moving Force, and are produc'd in the ſame Direction with that of the moving Force.

Effects are always proportionable to their *adequate* Cauſes, and if any Degree of Force produce any Degree of Motion, a double Degree of the ſame Force will produce a Double Degree of Motion, and a triple a triple, and ſo on; and this Motion muſt proceed in the ſame Direction

rection with that of the moving Force, since from this only the Motion arises; and because by the former Law, Bodies in Motion cannot change their Direction of themselves, so that unless some new Force alter its Course, the Body must proceed in the same Direction with that of the moving Force. And if the Body was before in Motion, the Motion arising from this impress'd Force, if in the same Direction, does so much increase the former Motion; if it has a contrary Direction, it destroys a part of the former Motion, equal to that which is impress'd; when it has a Direction oblique to that of the former Motion, it is either added to, or subtracted from the former Motion, according as the Motion arising from a Composition of these two, is determin'd.

## *Corollary.*

§ XIV. Hence it is evident, that in the present Constitution of things, there can be no perpetual Motion. By a perpetual Motion, I mean an uninterrupted Communication of the same degree of Motion from one part of Matter to another in a Circle: not as Bodies put in Motion do for ever continue in the same, but in so far as they are resisted or stop'd by other Bodies, but a Circulation of the same quantity of Motion, so that it perpetually return undiminish'd upon the *first Mover*. For by this Law

Law, the Motion produc'd is but proportionable to the generating Force; and all Motions on this Globe being perform'd in a reſiſting Fluid, *viz.* the Air, a conſiderable quantity of the Motion muſt be ſpent in the Communication, on this *medium*, and conſequently it is impoſſible the ſame Quantity of Motion ſhould return undiminiſhed upon the *firſt Mover*, which is neceſſary toward a perpetual Motion. Moreover, the Nature of Material Organs is ſuch, that there is no avoiding a greater or leſſer degree of Friction, though the Machin be formed according to the exacteſt Principles of *Geometry* and Mechanicks, there being no perfect congruity nor exact ſmoothneſs in Nature; the manner of the Coheſion of Bodies, the ſmall proportion the ſolid Matter bears to the vacuities in 'em, and the Nature of the conſtituent Particles of Bodies, not admitting the ſame. Beſides, how very imperfect our moſt finiſhed Mechanick Performances are, a very ordinary *Microſcope* will eaſily diſcover Now theſe things muſt very conſiderably diminiſh the communicated Force, ſo that it is impoſſible there ſhou'd be a perpetual Motion, unleſs the communicated Force were ſo much greater than the Generating Force, as to recompence the diminution made therein by all theſe Cauſes, ſo that the impreſs'd Motion may return undiminiſh'd to the firſt *Mover*. But that being contrary to this Law, it is clear, that the Motion muſt con-

tinually decrease, till it at last stop, and consequently there can be no perpetual Motion in the present State of Things.

## LAW II.

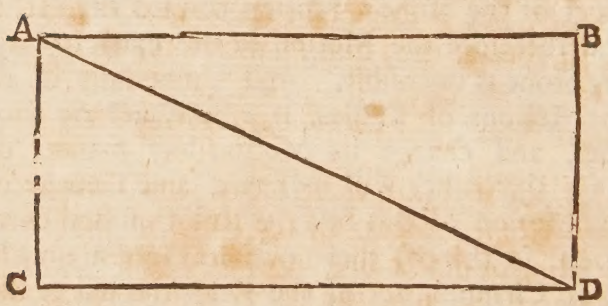
§ XV. REPULSE or Reaction is always equal to Impulse or Action, or the Action of two Bodies upon one another is always equal, but with a contrary Direction, *i. e.* The same Force with which one Body strikes upon another, is return'd upon the first by that other; but these Forces are impress'd with contrary Directions.

Whatever presses or draws another, is as much pres's'd or drawn by that other; if one presses a Stone with his Finger, the Stone presses his Finger again. If a Horse draw forward a Stone by a Rope, the Stone does equally draw back the Horse, for the Rope being equally distended both ways, act upon both equally. If one strike an Anvil with a Hammer, the Anvil strikes the Hammer with equal Force. The Steel draws the Magnet as much as the Magnet does the Steel, as is evident by making both swim in Water; so in pulling a Barge to Land by a Rope, the Bank pulls the Barge as much as the Barge does the Bank; and in the descent of heavy Bodies, the Stone attracts the Earth as much as the Earth does the Stone; *i. e.* the Earth

Earth gravitates toward the Stone, as much as the Stone does toward the Earth. And the Motions produc'd by both these Gravitations, are equal in both, only the Stone is altogether inconsiderable, in respect of the Bulk of the Earth, and consequently the Velocity of the Earth's Motion toward the Stone is inconsiderable, in respect of the Stone's Motion toward the Earth, and therefore the Motion of the Earth toward the Stone is insensible. And Universally in all the Actions of Bodies, if a Body act on another, and change its Motion any manner of way, that other will make the same Change in the Motion of this Body with a contrary Direction, so that by these Actions there are made equal Changes, not of the Velocities but of the Motion, for the Changes made on the Velocities in contrary Directions, are in a reciprocal proportion to the Bodies.

*Corollary* 1.

§ XVI. If a Body *A*, be impell'd by two different Forces, one in the Direction *A B*, with the Velocity *M*; another in the Direction *A C*,



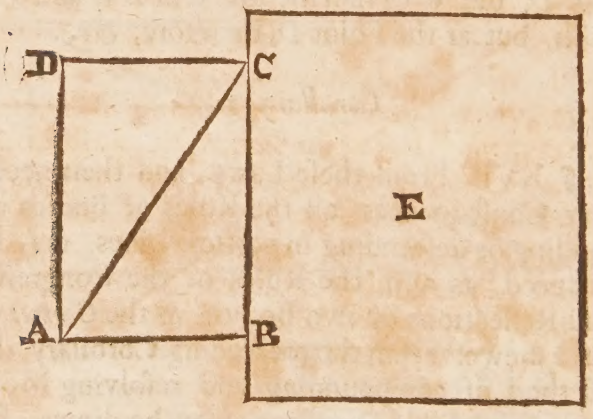

with the Velocity *N*, make *A B* to *A C*, as *M* to *N* compleat the Paralelogram *A B C D*. the Diagonal of which is *A D*. The Compoſition of both theſe Forces will make the Body deſcribe the Diagonal *A D*, and in the ſame time as it would have deſcribed either of the Sides; for becauſe the Force, whoſe Velocity is *N*, acts in the Direction *A C*, parallel to *B D*, it will not in the leaſt hinder or deſtroy the Velocity in the other Force, by which it tends to the Line *B D*. Wherefore the Body will reach *B D* in the ſame time, whether the Force, whoſe Velocity is *N*, be impreſs'd or not, and therefore in the end of this time it muſt be found ſome-

ſomewhere in *B D*, in like manner, the Force, whoſe Velocity is as *M*, acts in the Direction *A B*, parallel to *C D*, and therefore will not hinder the Velocity in the other Force in proceeding to *C D*, and the Body will reach *C D* in the ſame time, whether the Force, whoſe Velocity is *M*, act or not, and conſequently, in the end of the ſame time, it muſt be ſomewhere in *C D*, but it cannot be found in *B D* and *C D* both, but at the Point *D*, therefore, *&c.*

## *Corollary* 2.

§ XVII. From theſe Laws, and their neceſſary Conſequences, all the Rules of Bodies aſcending or deſcending in vertical Lines, may be deduced, as alſo, the Rules of the Congreſſes and Reflections of two Bodies, as the *Geometers* have ſhewn. From the preceeding Corollary, the Method of compounding and reſolving Motions in any given Directions may be drawn, for Example, *(ſee the former Figure)* the Compoſition of the direct Force *A D*, of any oblique ones, ſuch as *A B* and *B D*, as alſo the Reſolution of the direct Force, into any oblique ones, ſuch as *A B* and *B D*, and likewiſe the *ratio* of an oblique Force to move a Body, to that of the ſame Force coming with a perpendicular Direction to move the ſame Body; for Example, *(ſee the following Figure)* let an oblique Force, as *A C* be impreſs'd upon the Body *E*

in *C*, at the Point *C* erect a perpendicular *C D*, and from *A* let fall a perpendicular upon *C D*, and another upon *C B*; then by the former Corollary, the Force *A C* may be resolved into the two Forces *A D* and *A B*, of which only *A B* has any Energy to move the Body *E*; wherefore the oblique Force as *A C* is to the same

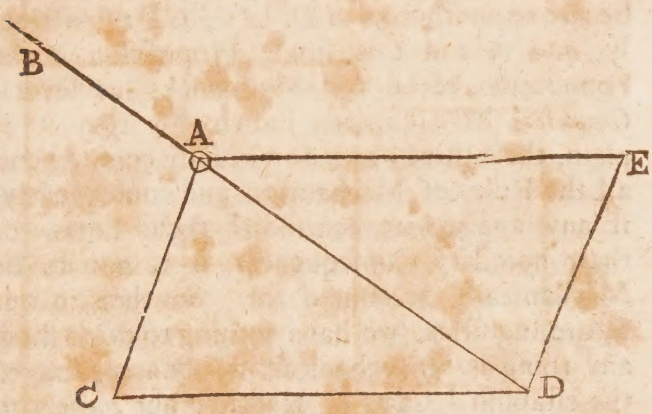



Force coming with a perpendicular Direction, as *A B* to *A C*, or as the sine of the Angle of Incidence *A B* to the Radius *A C*. The same is true of the Energy of an oblique Stroke upon the Body *E*, to that of the same striking perpendicularly.

From the same preceding Corollary, it follows that if a Body *A* be impell'd or drawn by three different Forces in three different Directions *A B*, *A E*, *A C*, so that the Body yields

to

to none of 'em, but continues in *æquilibrio*, these three Powers are to one another as three right Lines drawn parallel to their Directions, and terminated by their mutual Concourses. If *A D* represent the Force by which the Body *A* is impell'd from *A* to *B*, then will the same *A D* re-




present the contrary equal Force, whereby it is impell'd from *A* to *D*. But by the former Corollary a Force, as *A D* impelling from *A* to *D* is equipollent to two others, acting in the Directions *A C*, *A E*, to which the other impelling from *A* to *D*, is as *A D* to *A C*, and *A E* or *C D*, respectively. So likewise two Forces acting in the Directions *A C*, *A E*, and being equipollent to the Force Acting in the Directions *A D*, from *A* to *D* will be to the Force acting according to the Direction *A D*, from *A* to *D*, as *A C*, *A E*

to *A D*; and therefore the Forces acting in the Directions *A C* and *A E*, and equipollent to the Force acting in the Direction, *A D* are to this Force acting in the Direction *A D*, as *A C*, *A E*, or *C D* to *A D*, that is, if a Body be urg'd by three different equipollent Powers in the Directions *A B*, *A C*, *A E*, these three Forces shall be to one another as *A D*, *A C*, *C D* respectively, *q. e. d.* and this single Proposition is the Foundation of all the Mechanicks, as several *Geometers* have expresly shown; so that it is plain, these three Laws do virtually comprehend all the Rules of Mechanism, and consequently, if any appearance contradict these Laws, or their necessary Consequences, it is not to be Mechanically accounted for. So then in our future Inquiries, we have nothing to do to show any thing is Immechanical, or not according to the establish'd Laws of Nature; but clearly to evince, that it contradicts some of these Laws or their Corollaries.

CHAP.

## CHAP. II.

*Of Attraction or Gravitation in Bodies, and an account of some of the Appearances of Nature, from this Principle and these Laws now established.*

§. XVIII. HAving thus explain'd the Laws that uninterrupted *Nature* constantly pursues in bringing about her Purposes and Effects. I come in the next Place to apply these to the most simple, uniform and regular *Appearances* that have as yet been observ'd; and these are the Motions of the Celestial Bodies. Many repeated Observations, and almost every single *Appearance* of these Bodies, evidently demonstrate them to revolve in *Curve Lines*, and therefore by the 1st Law to be drawn out of their rectilinear Course, by some extrinsic Force acting on them. Let us then enquire how it comes about, that these Bodies do persevere in their Motions, and do constantly move round in the same Tracts, without making the least Deviation? Now, that can happen but one of these two ways, *viz.* Either by the Force of some *Celestial* Fluid (call'd a *Vortex*) which carries 'em about, or by some *Retentive Central Force* which hinders 'em from running out in strait Lines, when they are once put in Motion by

by the Fingers of him who fram'd this marvellous *Machin* of a World.

§ XIX. In order to account for the *Celestial* Appearances, *Des Cartes* supposes the Matter of this Universe to have been at first divided by Almighty God, into innumerable little equal Parts, each endow'd with an equal Degree of Motion, both about its own proper *Center*, and separately among themselves, so as to constitute a Fluid; as also that several Collections of these Parts, were endow'd with a Motion about different Points (at equal Distances) as common *Centers*, so as to compose different *Vortices*, and that these Parts being made round by such intestine Motions, did produce *Globules* of different Magnitudes, which he calls the Matter of his *second Element*; as also that the small Raspings and Filings of the Angular Points of these *Globules* driven violently many different ways, did make up the Matter of his *first Element*; and seeing there wou'd be more of this *first Element* than was sufficient to fill the Vacuities between the *Globules* of the *second Element*, he supposes that the remaining part wou'd be driven toward the *Centers* of the *Vortices*, by the Circular Motion of these *Globules*, which did for that reason recede from it; and being there amass'd in a Sphere, wou'd in the *Center* of every *Vortex* produce a Body like the *Sun*; that the Sun being thus fram'd, and moving about its own *Axe* with the Motion of the rest of

of the Matter of the *Vortex*, wou'd neceſſarily throw out ſome Parts of its Matter through the Vacuities of the *Globules* of the *ſecond Element*, which conſtitute the *Vortex*, eſpecially at theſe Places which are diſtant from its *Poles*, receiving by theſe *Poles* as much as it loſes about the *Ecliptick*, and by this wou'd be able to carry round with it theſe *Globules* which are neareſt, with the greateſt Velocity, and the remoter with a leſs; and that ſo of neceſſity theſe *Globules* that are neareſt the *Center* of the *Sun* would be leaſt, for were they greater or equal, they wou'd by reaſon of their Velocity, have a greater centifrugal Force, and therefore recede from the *Center*. Now ſhou'd it happen that any of theſe *Sun-like* Bodies in the *Centers* of the ſeveral *Vortices* ſhou'd be ſo incruſtated and weaken'd, as to be carried about in the *Vortex* of the true *Sun*, if it were of leſs Solidity, or leſs capable of Motion than the *Globules*, towards the extremity of the *Solar Vortex*, then it wou'd deſcend toward the *Sun*, till it met with *Globules* of the ſame Solidity, and capable of the ſame Degree of Motion with it, and being fixt there, it wou'd for ever be carried about by the Motion of the *Vortex*, without either approaching to, or receding from the *Sun*, and ſo become a *Planet*. Suppoſing this true then we may imagine our *Syſtem* to have been at firſt divided into ſeveral *Vortices*, in the *Center* of which was a lucid ſpherical Body, and

and that some of these being gradually incrustated, were swallow'd up by others, more powerful and bigger, till at last they were all destroyed and carried away by the biggest *Solar Vortex*, except some few that were thrown off in right Lines from one *Vortex* to another, and became *Comets*. Hence it appears according to this *System*, that the *Planets* that are neareſt the *Sun*, are least solid, which is *Des Cartes*'s Reason, why the *Moon* shows always the same Face to us, because that *Hemisphere* that is opposite to the *Earth*, is somewhat more solid than the other. As also that the Matter of the *first Element*, which makes up the Body of the *Sun*, moves with greater Velocity the Parts of the *Vortex*, and the Bodies swimming therein, that are neareſt it, than those that are remoter, which is the Reason why the *Planets* next the *Sun*, finish their Periods sooner than those that are more remote; and that these *Planets* move about their own *Axes*, because they were *Sun-like*, lucid, and revolving Bodies before.

§ XX. Now not to mention the many Defects in the Mechanical Production of this imaginary *System*, I shall only take Notice of the known *Celestial* Appearances it contradicts; and the Absurdities wou'd follow, tho' we shou'd allow the Author all that he wou'd have granted. And, 1. It is certain that a *Vortex* produc'd by the Revolution of a *Sphere*, about a giv'n *Axis*, wou'd be propagated *in infinitum*, if nothing

thing did hinder it; and ſeeing there muſt be as many ſuch *Vortices* as there are fixt Stars, one *Vortex* wou'd neceſſarily run into another, and every Particle wou'd be acted by a Motion compounded, of the Motions of all the *Central Spheres*, which is abſurd, and contrary to that Conſtancy and Limitation obſervable in the Celeſtial Appearances. 2. Since the Motion of the Parts of the *Vortices* neareſt the *Center* is ſwifter than that of the more remote, they will preſs upon the exterior Parts, and thereby perpetually communicate ſome part of their Motion to them, and therefore theſe interior Parts of the *Vortex*, will be continually loſing ſome part of their Motion, which never being reſtored, theſe Parts muſt gradually move ſlower, till at laſt the Motion is quite deſtroy'd. 3. According to this *Hypotheſis*, each *Planet* is of the ſame Denſity with the Parts of the *Vortex* in which it ſwims, and is govern'd by the ſame Laws of Motion, and is, as it were, only concreted Parts of the *Vortex*: Now the times of the periodical Motion of Bodies, carry'd about by a *Vortex*, are in a duplicate proportion of the Diſtances from the Center; whereas the Squares of Times of the periodical Motions of the *Planets*, are as the Cubes of the Diſtances from the *Center*, and conſequently the *Planets* cannot be carry'd about by a *Vortex*. 4. If a *Vortex* run out *in infinitum*, then a Body carry'd round by it, wou'd certainly deſcribe a perfect

perfect Circle, unless something solid did hinder it, and therefore, the greater Distance there were between these solid Bounds, or the larger the Bason were which contains the *Vortex*, in respect of the *Orbit* of the Body carryed about in it, the nearer wou d this Orbit approach to a Circle, *i e.* The Excentricity of the *Planets* nearest the *Sun*, would be less than that of those more remote, the contrary of which is true, for that of *Mercury* is greater than that of *Saturn* Moreover, since the *Planets* in this *Vortex* wou'd necessarily move in Orbits nearly similar to that of the sides of the containing Bason it wou'd follow that the *Aphelia* of all the *Planets* seen from the Sun, wou'd be directed towards the same fixt Stars: but this too is contrary to Observation. Likewise the Matter of the *Vortex* (as of every Fluid) when bound up within strait Bounds, must necessarily move faster than when enlarg'd in a wider Channel; *i e* The *Sun* seen from the Earth, must seem to move faster in the beginning of *Virgo*, than in the beginning of *Pisces*, which contradicts Experience 5. A Body carry'd about in a *Vortex* of the same density with it, wou'd necessarily describe a Circle to whose Plane, the Axis of the central Body which produces the Circulation of the Fluid, wou'd be perpendicular; but there is not one *Planet* to the Plane of whose Orbit the *Sun*'s Axis is perpendicular Lastly, The *Comets* have their Orbits, not only oblique, but

but ſometimes at right Angles with the Plane of the Ecliptick, ſometimes the Courſe of theſe *Comets* is Diametrically oppoſite to that of the *Sun*; they perſevere in their Motions without any change, they deſcribe equal *Area's* by a *Radius* from the *Sun* in equal times, they enter into the *Vortex* of the *Sun*, all which is impoſſible, if the *Solar Vortex* mov'd round with Force ſufficient to carry theſe vaſt Bodies of the *Planets* along with it.

§ XXI. This *Hypotheſis* is ſomewhat altered and mended by the famous Mr. *Leibnitz*, he accommodates it better to the Celeſtial Appearances, and makes it agree more exactly to the Rules of *Geometry*. He firſt of all ſhows, that all Bodies which in a Fluid deſcribe a *Curve-Line*, are mov'd by the Fluid, for of themſelves they wou'd deſcribe right Lines, and nothing but the Fluid concurs to turn them out of their way. He next ſhows, that every *Planet* is carry'd about by a Motion compounded of two other Motions, *viz.* an *Harmonical Circulation* of the carrying Fluid, and a *Paracentrical Motion* of acceſs to, or receſs from the *Sun*. For underſtanding theſe Terms, we muſt obſerve that the *Planets* deſcribe *Area's* by a *Radius* from the *Sun*, proportional to their times. Now the Fluid that carries the *Planets*, muſt of neceſſity circulate ſo as to produce this effect, which cannot be done otherwiſe, than by ſuppoſing innumerable concentrical Orbs of exceeding thinneſs

thinness to make up the *Vortex*, every one of which has its own proper way of Circulation, *viz.* those Orbs that are nearest the *Sun* circulate fastest, and the Velocities of the Circulations are every where reciprocally proportional to the Distances of the respective Orbs from the *Sun*, which will necessarily make the *Planet* in whatever part of *Vortex* it is, describe equal *Area's* in equal Times; for these *Area's* are in a compounded proportion of their *Radii* or Distances from the *Sun*, and a reciprocal proportion of the Arches or Lengths of the Circulations, which in this case will make a proportion of equality, and this Law of Circulation of the *Vortex* he calls *Harmonical*. The *Paracentrical* Motion is compounded of two others, *viz.* the *Excussory* Impression of the *Harmonical* Circulation, whereby all Bodies moving in a *Curve*, endeavour to recede from the *Center* by the *Tangent*, and the Attraction of the *Sun* or the Gravitation of the *Planet* toward it; and this Mr *Leibnitz* is of Opinion, arises from an Impulse communicated by the Circulating Fluid. Now since the *Planets* move in *Elliptick* Orbits, in one of whose *foci* the *Sun* is, and by a *Radius* from the *Sun* describe equal *Area's* in equal Times, which no other Law of a Circulating Fluid, but the *Harmonical* Circulation can account for, we must find out a Law for the *Paracentrical* Motion, that may make the Orbits *Elliptick*. The *Excussory* Impression of the Circulating

culating Fluid, wou'd throw off the *Planet* from the Center by the *Tangent*. Wherefore the Attraction of the *Sun*, or the Gravitation of the *Planets* towards it, muſt be ſufficient to deſtroy this Effect; and beſides, to make them move in *Elliptick* Orbits, which cannot be brought about, unleſs this Attraction or Gravitation be reciprocally as the Squares of the Diſtances from the *Focus*, which is the Sum of *Leibnitz*'s Doctrine upon this Head.

§ XXII. But even this Account of the Celeſtial Motions is both precarious and inſufficient, for theſe Reaſons. 1. The *Comets*, as was formerly ſaid, have their Orbits, ſome of them very oblique, nay, ſometimes at right Angles with the *Zodiak*, and ſometimes the Courſes of theſe *Comets* are quite contrary to that of the *Planets*: Now the *Comets* deſcribing about the *Sun Area's*, proportional to the times, muſt be carry'd about by a *Harmonically* circulating Fluid, as well as the *Planets*, and thus we ſhould have *Vortices* contrary to *Vortices*, which is very abſurd. 2. This Suppoſition is not only unreaſonable, but diſagreeable to the uniform Simplicity of Nature; nor is there any thing in the Motions of the Heavenly Bodies ſo difficult to explain, as this very *Hypotheſis*, which is introduc'd to account for them. Beſides, 3. In equable Motion, the Times are always as the Spaces directly, and the Velocities reciprocally; but in a Circular Motion, the Spaces in one Re-

volution are as the *Radii*, and in an *Harmonical* Circulation, the Velocities are as the *Radii* reciprocally, and therefore the periodical Times of a Fluid circulating *Harmonically*, are in the Duplicate Proportion of the *Radii*. Now the periodical Times of the *Planets*, are in Sesquiplicate Proportion, and not a Duplicate Proportion of the Distances from the *Center* or the *Radii*, and consequently the *Planets* cannot be carried about by an *Harmonically* circulating Fluid. To this it may be answer'd, that this *Harmonical* Circulation is not continued from *Mercury* to *Saturn*, but is interrupted, and reaches only from *Mercury*'s *Perihelium* to his *Aphelium*, and there breaks off, and begins again at *Venus*'s *Perihelium*, and reaches to her *Aphelium*, and is there again interrupted, and so on through the whole System of *Planets*: But what a ghastly and unsightly kind of Deformity there would happen on this Supposition? Every one may easily see, this is not like the uniform and simple Measures of Nature. Besides, the *Comets* moving forward in the *Zodiack*, pass through all these Chasms and Interstices, and notwithstanding, move in the same manner, as if they were carried by a Fluid, circulating *Harmonically* according to some uniform Law, neither do their Appearances shew the least Suspicion of these Interruptions.

§ XXIII. It being thus prov'd, that the Celestial Bodies do not revolve by the means of any

any circulating Fluid, they must be kept in their Orbits, by some *Attractive* Power in the *Sun*, or by some gravitating Power in them towards him, which is the same thing, since it must be mutual by the third Law. This Gravitating or Attracting Power of the great Bodies of the Universe towards one another, some *Philosophers* endeavour *Mechanically* to account for, from the Action of a Subtile Matter, which violently whirling round the *Sun* in general, the *Earth* and the rest of the *Planets* in particular, and acquiring thereby a Power of receding from the Center, impels Bodies towards that Center about which the strongest Circulation is made; or being driven with an immense Velocity in right Lines according to all possible Directions, impels the Body according to the Direction of that part of this Subtile Fluid, which is least resisted by the interposition of other Bodies. And thus, not only Bodies within the Sphere of the *Earth*'s Activity are impell'd towards it, but also the *Planets* do gravitate towards the *Sun*, but without entering into the particular manner of the Explication of Gravitation according to this Scheme, there be two or three Objections against all the possible Accounts of Gravity in particular, or Gravitation in general from the Circulation of a Subtile Matter. 1. It is impossible from the first Part of this *Hypothesis*, to account for Bodies gravitating towards a Point, for the Motion *quaquà versum* in a great Circle

of the Sphere, which is alledged to salve this Difficulty, is a Contradiction to Nature, no such thing being either conceiveable or possible. 2. It is impossible to explain whence the Circular Motion of this subtile Fluid comes, there must be conceiv'd another subtile Fluid moving after some certain manner to produce the Motion of that Fluid, which is the Cause of Gravity, and so on in *infinitum*, or else we must admit its Motion without any Cause, which is harder to conceive than Gravity it self. 3. That Matter which is the Cause of Gravity, or by whose Motion it is produc'd in all the possible *Mechanical* Explications thereof, must be without Gravity which is absurd, Matter being every where in reason to be suppos'd of the same uniform Nature, and its Gravity to be always proportional to the Quantity of its solid Mass. For since all the Bodies we can make Observations upon are heavy, as well as extended and impenetrable, it is reasonable to conclude so of all Bodies whatsoever, else all *Universal Properties* in Philosophy must be given up: And therefore it is Absurd to suppose there are some Portions of Matter without that Quality which every Portion of Matter we can make Observations on has. 4. Bodies from the Impulse of a Fluid can only gravitate in proportion to their Surfaces, and not according to their Quantity of Matter, which is contrary to Experience; for we find all Bodies gravitate in proportion to their

their Solidities, *i. e.* their Quantity of Matter; And tho' this Difficulty may be remov'd, by ſuppoſing Bodies to conſiſt originally of *Cylinders* of infinitely ſmall *Baſes*, for on ſuch a Suppoſition, theſe *Cylinders* wou'd be to one another as their Surfaces, their *Baſes* being nothing, and conſequently, the Gravities of Bodies, which by the Action of this ſubtile Fluid are as their Surfaces, wou'd be alſo as their Solidities, *i. e.* the Quantities of Matter they contain, ſince the Surfaces of the original Particles of Bodies are as their ſolid Contents. Yet this is ſo very hard a *Poſtulate*, to require Bodies to be diverſified, only by the Lengths of their primitive conſtituent *Cylinders*, that I can't ſee how it can poſſibly account for all the varieties of Colours, Taſtes and Smells, and other ſenſible Qualities of Bodies which ariſe from the Diverſities of the Texture and Figure of their conſtituent Parts. But that which in my Opinion, overthrows all ſuch *Mechanical* Accounts, however artfully contriv'd, is that, 5. There ſeems to be neceſſary toward a full Explication of the Appearances of Nature, ſeveral different Conditions of this Univerſal Law of *Gravitation*, which cannot be *Mechanically* explain'd, without ſuppoſing different Syſtems of this Fluid, to move after different Manners, and according to different Laws, which will neither accord eaſily together, nor ſeem like the Limitations and Simplicity of Nature. That there are different

Conditions of the Universal Law of *Gravitation*, necessarily to be suppos'd, seems evident from the Nature of Light, as Sir *Isaac Newton* has explain'd it from certain Experiments; and there are other Appearances in Nature, that seem to require Conditions different from that which governs the Motions of the Celestial Bodies, and causes the inflexions of the Light, as shall be afterwards shown. Now, to account *Mechanically* for these different Conditions of the General Law of *Gravitation*, there must of necessity be suppos'd various and different Systems of this subtile Fluid, which looks a little odd, especially if we consider, that is not as yet known how many and how different these Systems must be suppos'd, to account for all the various Conditions of this General Law, that may hereafter be discovered necessary to explain the various Appearances of Nature. 6. Lastly, this whole Affair is more Naturally and Simply to be accounted for from Principles now to be laid down.

## *Corollary.*

§ XXIV. From what has been said it appears that the Attraction or Gravitation of Bodies toward one another, is not to be *Mechanically* accounted for, and since it has been likewise shown, that the *Planets* cannot continue their Motions in their Orbits, without the Supposition of such an

an Attraction or Gravitation, it is evident, that this must be a Principle impress'd on Matter by the *Creator* of the World; it is a Principle no ways essential to Matter, since it is the Source and the Origin of the Celestial Motions, as Sir *Isaac Newton* has demonstrated. And by the first Law of Nature and its Corollaries, no kind of Motion is essential to Matter, and therefore Attraction or Gravitation cannot be essential to it; it is not a Result from the Nature of Matter, because the efficacy of Matter is communicated by immediate Contact, and it can by no means act at a distance; for we see an Object, because the Light reflected from thence strikes immediately upon our Organs of Vision, we smell, because parts of the odorous Body touch the Nerves of our *Nostrils*, and universally all the other Natural Effects of Material things are perform'd by the meer Impulse of one Body on another, whereas this Power of Gravitation acts at all Distances without any *Medium* or Instrument to convey it, and passes as far as the Limits (if any such there are) of the Universe. And acts, not like *Mechanical* Causes, according to the Quantity of the Surfaces of Bodies on which it acts, but in proportion to the Quantity of solid Matter which these Bodies contain. Besides, by the first Law of Nature, Matter is entirely passive in its Nature, and can no more tend to, or draw other Bodies than it can move of it self; likewise supposing this Gravitation

of the parts of Matter toward one another destroy'd, yet still Matter wou'd be the same extended solid Substance. Moreover, if there were but one indivisible Part of Matter in being, it could not be said to have this Property, it being a Relative one, and having respect only to other Parts which it attracts; whereas Impenetrability or any other of the essential Properties of Matter continues with it, ev'n when it becomes indivisible. On the other Hand, if the whole Quantity of Matter now in being, were *amass'd* so together, that there were neither Motion nor Vacuities in it, (neither of which Suppositions imply a Contradiction; for if any two Particles of Matter can be so compacted as to admit no Vacuity between them, then it is no contradiction to suppose the whole *aggregat* of Matter so *amass'd*, and we are demonstrably certain, Motion is not essential to Matter) then the whole *Mass* would either be without this Quality of *Attraction*, or this Quality would be absolutely useless or without Effect, which is much the same thing in an active Quality, as this of *Attraction* is. Lastly, as Motion is in some Circumstances, the necessary Effect of gravity in Bodies, and in other Circumstances must have proceeded from an original Impression, (as in the *projectile* Motion of the *Planets* along their *Tangents*) and yet is of the same absolute Nature in both Cases, and certainly, is not *essential* to Matter; so *Attrā-*

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*ction* or *Gravitation* is not *essential* to Matter, but seems rather an *original Impress* which continues in it, by virtue of the *Omnipotent* Activity, in the *Divine Nature* of which it is a *Copy* or *Image* in the low Degree that is suitable to a gross Creature, and so may now be reckon'd among the *primary* Qualities of Matter, without which, as it is now constituted Matter cannot be, but did not *Originally* belong to it as a *Materia prima*. On all which Accounts, its highly probable that this Universal Force of *Gravitation* is the effect of the *Divine Power* and *Virtue* originally impress'd on, and by that first *Energy* continued in Matter, by which the Activity and Operations of Material Agents are preserv'd. And this Power of *Gravitation* being thus impress'd on Matter, is one reason of the Distinction between the Laws of *Creation* and *Nature*, for tho' the *Energy* of that first Impression does still last, and is the Source and Spring of the *Uniformity* and Continuance of the *Celestial* Motions, yet its not being essential to Matter, nor arising from its Nature, is the reason why it ought not to be reckon'd among those Laws which arise from the particular Texture, Figure and Disposition of Bodies, such as most of the Laws of Nature or Motion are. The chief Difficulties that I can find have straitned Learned Men, in admitting this Principle of the Universal Law of the *Gravitation* of Bodies upon one another are, 1. That they cannot conceive how this Principle can be

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*Mechanically* accounted for; and they think it *Unphiloſophical* to admit any Principle in the Explication of the Appearances of Nature which can't be thus accounted for. It is indeed in my Opinion certain, that this Principle cannot be *Mechanically* accounted for; for there is no other *Mechanical* Cauſe conceivable, this Principle of the *Gravitation* of Bodies upon one another, can ariſe from, but the Motion of ſome ſubtile Fluid, and were there no other Argument againſt all poſſible Explications of *Gravitation* ariſing from the Motion of a ſubtile Fluid, but this one, *viz.* that thereby theſe Parts of Matter which are the Cauſe of, or produce *Gravitation*, are upon this Suppoſition, deſtitute of Gravity; I ſhou'd think it ſufficient to prejudice any inquiſitive Man againſt ſuch Explications; for it's certain that Nature is uniform and conſiſtent with it ſelf, and wou'd not deprive one part of Matter of ſo Cardinal a Property, with which ſhe had endow'd all the reſt. The whole Foundation of *Natural Philoſophy*, is *Simplicity* and *Analogy*, or a Simple, yet Beautiful *Harmony*, running through all Works of Nature in an uninterrupted Chain of Cauſes and Effects, with proper Limitations of Circumſtances: And if theſe Principles be ſuperſeded, or this Chain broken, we can expect nothing but Abſurdities and Inconſiſtences in *Philoſophy*. But even the admiſſion of ſuch an *Hypotheſis* removes us but one Step further from *Immechanical* Principles,

ciples, for the Cauſe of the Motion of this ſubtile Fluid, which is the Cauſe of Gravity, is it ſelf *Immechanical*. Nor has any Body ever pretended to aſſign any other Cauſe of the Motion of this ſubtile Fluid, but the *Omnipotent Cauſe* of the *Univerſe*; and ſince we muſt of Neceſſity admit the Motion of this ſubtile Fluid, which is the Cauſe of *Gravitation* to be unaccountable without a *Firſt Cauſe*, why may we not rather admit this *Firſt Cauſe* to have impreſs'd this Property in Matter, ſince that this Difficulty is the ſame in both; and that beſides, the firſt Suppoſition is burthen'd with ſeveral Additional ones, to which the ſecond is not liable. There has never been any Syſtem of *Natural Philoſophy* offered to the World as yet, that does not require ſome *Poſtulates* that are not to be accounted for *Mechanically*; the feweſt any one pretends to, are the Exiſtence of Matter, the Impreſſion of Rectilinear Motions, and the preſervation of the Faculties of Natural Agents, which no Man has pretended to account for from Principles of *Mechaniſm*; and the Impreſſion of an *attractive Faculty* upon Matter, is no harder *Poſtulate* than any of theſe; but ſince it is Matter of Fact and Demonſtration, that Matter is in poſſeſſion of this Quality; for we daily ſee, that the Earth draws to its Center all Bodies within its Activity, we muſt allow of it, whether it be to be *Mechanically* accounted for or not; and ſince it is not to be accounted

for

for from *Mechanical* Principles, as I think, I have demonstrated, we must of necessity refer it to the Power and Influence of the *First Cause* of all things. For Causes proceed in a continual *Chain*, from more complex to more simple Ones, and at last to the most Simple; and when we are arriv'd at that Cause, we can go no further, else that Cause would not be the most Simple; and this most simple Cause cannot be *Mechanically* explain'd whatsoever it may be, else it could not be the most Simple: And therefore since we must admit of *Immechanical* Causes, since *Gravity* is undeniably the Property of all the Bodies we can make Observations upon, and is sufficient to account for the *Appearances* of all those Bodies that revolve about us, as Sir *Isaac Newton* has shown, there can be no Reason for rejecting it, tho' it cannot be *Mechanically* explain'd. 2. Another Difficulty ingenious Men have in the Conception of this Quality in Matter, is, how it can act at a Distance without any *Medium* to convey this Action, as of necessity it must. Now, were there no other Difficulty of the like Nature in Philosophy but this one, it might stumble judicious Persons; but we know the manner of *Thinking* and *Reflection*, of *Remembring* and *Sensation*, are things not easily to be explain'd, and yet we must admit them. The Communication of Motion from one part of Matter to another, and ev'n the first Production of Matter and Motion,

Motion, are not to be accounted for, and yet there is no denying that such things really are, when we are capable to explain how our Souls and our Bodies act mutually upon one another, we may come to be able to conceive how Matter acts at a Distance without any *Medium*; but till then, it is sufficient to know, that such a Quality is actually lodg'd in Matter, and that it is the Cause of all the Great and Uniform Appearances of Nature. There is no Contradiction, in supposing that the same Effects may arise from Causes not altogether the same, but that only can be the true Cause from which the Effect truly proceeded. Other imaginary or *Hypothetical* Causes, have no place in true *Philosophy*. In *Clocks*, for Example, the Hand on the Dyal-Plate, may be mov'd by a *Spring* or *Weight*; but if a particular *Watch* were propos'd, he wou'd say nothing to the Purpose, who shou'd explain all its Motions by a Spring; when upon looking within it, he might have found a Weight perpetuating the Motion of the Machin, which yet he cou'd not explain by Rules of *Mechanism*. No wise and honest Man, who throughly understands the Matter, will offer to explain by Rules of *Mechanism*, how this *System* of things was produc'd, nor how the Faculties of Material Organs are preserv'd, whence they arose, and what way they communicate their Actions and Influences to one another; it will suffice such, from the Present Appearances to investi-

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gate the Powers and Forces of Nature, and from these to account for future Observations and Appearances; if we admit an *infinitely Wise and Powerful Being* to have made this World, there will be little Difficulty in allowing him to have impress'd on Matter what property he pleas'd, and if we will not admit of such a Being, there are much greater and harder Difficulties in the *Mechanical* Explication of the Nature of things to be surmounted, as shall be afterwards shown.

No Body who is but tolerably acquainted with the most probable Discoveries in Natural *Philosophy*, can imagine these to reach any farther than some of the grosser *Lineaments*, or more conspicuous *Out-lines* of the Works of the *Almighty*; since he must be very Ignorant, who can think to search *Him or his Works out, to any tolerable degree of Perfection. Simplicity* and *Harmony* are the surest Marks that the Discoveries made are of the true Kind, and *Analogy*, the best Rule to make them by. This is so evident in the Principle of *Attraction*, that I shall here, tho' not its most proper Place, observe a few *Hints* tending that way. God has most certainly implanted something *Analogous* to *Attraction*, in the greatest *Central* Body of each *System* towards the lesser ones of the same: Or, a Principle of *Gravitation* in these lesser ones towards the greatest *Central* one, and towards each other. From hence, and from their

their directly impreſs'd Motions, all their comely, regular and uniform Revolutions, Appearances and Actions upon one another ſpring. Thus it is in the great Bodies of the Univerſe. Something Analogous to this is the Spring and firſt Mover (at leaſt acting in the Order of God and Nature it ought to be) of all the noble and regular Actions of ſpiritual Beings. God being the *ſole ſovereign, ſelf-exiſtent* and *independent* Being, when he made Creatures partaking of himſelf, Images, *Emanations, Effluxes* and Streams out of his own *Abyſs* of *Being*, could not but impreſs upon their moſt *intimate* Natures and Subſtances, a *Central* Tendency toward Himſelf, an Eſſential Principle of *Re-Union* with himſelf; which in him is a Principle of *Attraction* of them towards him, *Analogous* to this Principle now mention'd in the Great Bodies of the Univerſe. As well might we ſuppoſe an exquiſite Artificer voluntarily producing a piece of Work which ſhould be the Reverſe of his own *Idea:* As well may the *Ray* be ſuppoſed *Diſſimilar* to the Body of the *Sun*, or the *Stream* to the *Fountain-Head*; as that infinite Power and Perfection ſhould produce a *ſpiritual* Creature, that had a neceſſary Tendency to *ſhun* or *fly* away from him, or even be in a ſtate of Indifferency toward him. *Self-exiſtence* and *infinite Power* muſt needs ſubject all Beings to it ſelf, and infinite Perfecti-

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on must do it so, as must be most *congruous* to the Nature of the Creatures it produces, in order to make them as happy as they can be made; and therefore God could not make spiritual Creatures, but he must implant the Principle of *Re-union* in them, in order to bring them back to himself, that is, to make them happy: This is the *Origin* of Natural *Probity* and *Conscience*. It is true, this Principle may be, and in most actually is, buried under Matter and Sensuality; extinguish'd, as it were, by the more powerful *Attractions* of present sensible Objects, the Allurements of Carnal Enjoyments, and the violent *Distractions* of the Pleasures of this World; so that it is not easily perceiv'd, but by those who have for some time faithfully follow'd its Direction and *Drawings*. But it is no less an essential Principle in a *spiritual Creature*, tho' thus stifled and oppress'd, than the Rational Soul is of an *Ideot*, tho' its Operations and Evidence be hindred and obstructed thro' the inept Organsation of its Body. This Principle of *Re-union* in *spiritual* Beings, whenever disentangled, unfolded, attended to, and regularly follow'd, will as infallibly lead these to their proper *Center* of Light and Bliss, and unite them for ever with it, as the Sun's *Attraction* will bring about the Seasons and Changes of the Year. On the other hand, if this Principle have not its *Energy* in this Life,

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when ever the Charms and *Attractions* of Senſe ceaſe, the acquired Principle of *Diſſimilarity* muſt repel theſe Beings with infinite Force from their Centre, ſo that the Principle of *Re-union* being ſet free by Death, and diſintangled, and acting conſtantly, becauſe Eſſential, muſt drive theſe Beings towards God their *Original Centre*, and the Principle of *Diſſimilarity* repelling them, or forcing him to repell them with infinite Violence from him, muſt of neceſſity make them infinitely Miſerable. Thus the future Happineſs or Miſery of *ſpiritual Creatures*, depends on this Principle of *Re-union*, as indeed their preſent does likewiſe; for whatever is in the order of its Nature, that is of God. its Origin, muſt be Happy, ſince he is ſo; and whatever is in a violent or unnatural State, that is, in a State oppoſite to God and Happineſs, muſt be in Miſery. As the Planets diſturb'd by no other *Attractions*, but from their *Central Orb* of Light, and one another, revolve in comely Order and beautiful Harmony, ſhedding their benign Influences on one another: So *ſpiritual Creatures*, following the *Drawings* of the luminous *Centre* of their Being, and giving themſelves up to the Direction of their innate Principle of *Re-union*, enjoy the whole Felicity of their Natures in their preſent State, advance in Purity and Perfection, and in mutual Benevolence and good Will towards one another. For as Motion is the neceſſary Conſequence of *Attraction*

*traction* in Bodies that have nothing resisting them from without, so *Love* and *Benevolence* towards their great *Origin*, and towards one another, is the necessary Effect of this Principle of *Re-union* in free Creatures, when unfolded. As the *Vapours*, and even the *Planets* are purified by the *Sun*, and in some Sense made *similar* to, and converted into his Substance, by being rais'd nearer to his glorious Body: So *spiritual Creatures* are yet more refined, spiritualized, and made liker the *Deity*, the nearer they approach to the Fountain of Purity and Perfection, by faithfully following his *Attractions*: which too, like the *Suns*, are powerful and vigorous; infuse Light and Strength, tho' not sensible. In a Word, as the *Attraction* of the *Sun* on the *Planets*, makes them first move, and then describe regular *Orbits*, so this Divine *Attraction* in spiritual Beings, animates the Will, and actuates the Affections, and these do all the rest that is to be done in this present State: And as the discordant *Attraction* of some wandring *Comets* wou'd certainly distract and disorder the *Harmony* of the Motions and Revolutions of the *Planets*, if they approach'd too near them; so gross irregular carnal Affections, earthly and sensual *Attractions* admitted too nigh, disturb and destroy the beautiful Progress of *spiritual Beings*, towards the *Centre* and End of their Being. *Vide* Cap. 2. Part 2.

§. XXV.

§ XXV. The great and primary *Law* then, imprinted by the Author of Nature upon all the Bodies of this Univerſe, is that every part of every Body attracts every part of every other Body; and the moſt general Conditions of this Law are, that the *Force* by which one part attracts another in different Diſtances from it, is reciprocally as the Squares of thoſe Diſtances; and that at the ſame Diſtance, the *Force* of the Attraction or Gravitation of one part toward divers others, is as the Quantity of Matter they contain: By the Virtue and Efficacy of this Law, the *Planets* muſt perpetually move in *Elliptick* Orbits, if they meet with no reſiſtance in the Spaces in which they move. For ſince it has been obſerv'd, that all Bodies perſevere in their ſtate of reſt, or moving uniformly in a ſtreight Line, but in ſo far as they are forc'd out of this State, by ſome *foreign Violence* impreſs'd on them; it follows from thence, that Bodies which move in *Curve* Lines, and which are therefore forc'd out of their ſtreight Courſe, which would have been the *Tangents* of theſe Curves, muſt needs be retain'd in theſe *Curve Orbits*, by ſome *foreign Violence* perpetually acting on them. The *Planets* therefore which revolve in *Curve Orbits* (becauſe returning again in the ſame Tract perpetually) muſt neceſſarily have ſome *foreign Violence* perpetually acting on them, by whoſe Influence they are drawn out of their *Tangents*.

Moreover, since it is demonstrated, (*Prop.* 2. *Lib.* 1. *Princip. Phil. Newtoni.*) that Bodies, which move in a *Curve*, on a Plane, and by a Line drawn from them to a Point, fixt, or however moved, describe about that Point *Area's* proportional to their times; are urged or drawn by a Force tending to, or whose Direction is toward that Point; and since by *Astronomical* Observation it is certain, that the *primary Planets* about the *Sun*, and the *secondary Planets* about the *primary Ones*, describe equal *Area's* in equal times. It is evident, that the Direction of the Force, whereby the *Planets* revolve in their *Orbits*, is toward their *Centers*: and this Force may be very properly call'd *Attractive* in respect of the *Central* Body; and *Centripetal*, in respect of the revolving Body. Lastly, Since it is likewise demonstrated, (*Coroll* 6 *Prop.* 4. *Lib.* 1. *Princip. Phil. Newtoni.*) that if Bodies move equably in *Concentrick* Circles, and the *Squares* of their periodical Times be as the *Cubes* of their Distances from the common Center; or, if Bodies revolve in *Orbits* that are pretty near *Circles*, and the *Apsids* of these *Orbits* be fixt: then the *Centripetal* Forces of those Bodies, will be reciprocally as the *Squares* of the Distances. And that the One of these Cases, or the Other, is Fact, is universally acknowledged by all *Astronomers*: and consequently the *Centripetal* Forces of the *Planets*, are as the *Squares* of their Distances. Now that we may have a general View,

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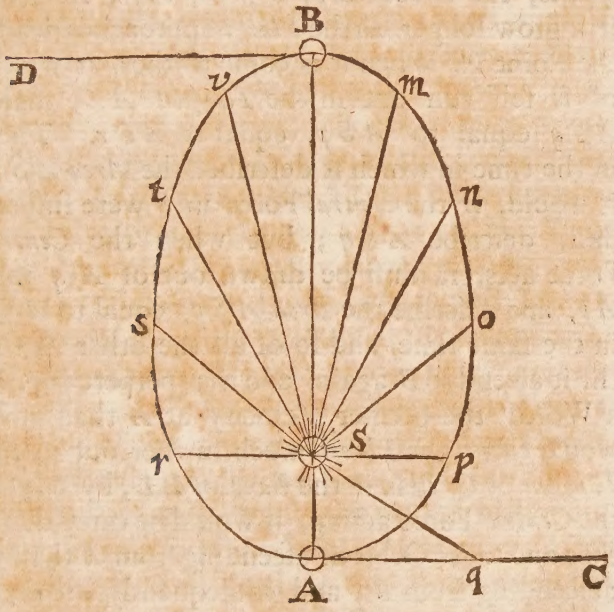
how a *Planet* by the ſame Law, can be made approach to, and recede from the *Attractive* Central Body, which ſeems the greateſt Difficulty in this Caſe; let us conſider the following *Scheme*, wherein let *S* repreſent the Sun. *A o B s*, the Orbit of a Planet *B*, deſcending from *B* to *A*. Let the time of its Revolution




be divided into equal Parts, and then they will be repreſented by the equal *Area's* which are ſuppoſed to be deſcribed by the Line *B S*, drawn through the Body of the *Planet B*, to the Sun *S* in its ſeveral Stops; *v*, *t*, *s*, *r*, *A* and

these *Area's* will be the *Triangles BSv, vSt, tSs, sSr, rSA.* Now since the *Attraction* in *S* encreases reciprocally as the *Squares* of the Distances, the Velocities of the *Planet* in its descending towards the *Sun*, must be encreased by the encreasing *Central* Force on it, which must make the *Bases* of these *Triangles* larger, that is, the *Arches Bv, vt, ts, sr, rA*, must still grow longer, as the *Planet* approaches nearer the Point *A*. When it is come thither, it wou'd of it self run out in the *Tangent AC*, make *ASq* equal to *ASp*, equal to *ASr*. Then in the time in which it described the *Area ASr*, it would, if the *Central* Force in *S* were suspended, describe *ASq*; but when the *Central* Force acts, it must be drawn out of *Aq* into *Ap*, and describe the *Area ASp*, equal to *ASq* in the same time, and so of all the other *Area's*, till it ascend to *B* again, and that perpetually. In a Word, the greater Velocity at *A* than at *B*, wou'd carry the *Planet* much further out in the *Tangent AC*, than in the *Tangent BD*, by which, the *Central* Force acting, it wou'd be carry'd further out in its Orbit in ascending from *A*, than in descending from *B*; and consequently, it must approach to *S* in descending from *B*, and recede from *S* in ascending from *A*. By Virtue of the same Law, and of these Conditions, the *Moon* will for ever turn round the Earth, as the Earth doth round the *Sun*, and the *Satellits* of *Saturn* and *Jupiter* round them; as also the *Comets*

*mets* will in very oblong *Elliptick* Orbits deſcribe about the *Sun* equal *Area's* in equal times; but becauſe the *Sun*, not only attracts the *Planets* and *Comets*, but alſo theſe the *Sun*, and likewiſe the *Planets* attract one another, their Orbits will be ſomewhat irregular, and differ from exact *Ellipſes*, which will be more ſenſible in the Motions of the *Moon*, becauſe She is ſo near to us; and this one Conſideration well apply'd, will account for all the Irregularities hitherto obſerv'd in the Celeſtial Appearances, as Sir *Iſaac Newton* has ſhown; likewiſe, ſince a great part of this our Globe is covered over with Water, it is plain, that by the joint Force of the Attraction of the *Sun* and *Moon*, the Water that lyes directly under them, will be rais'd above its ordinary Level, which will likewiſe happen if they are directly in the oppoſite part of our Globe, becauſe the remoter parts of the Water will be leſs attracted than the nearer, and the Motions produc'd in the Waters by the Attraction of theſe two *Luminaries* can't be obſerv'd ſeparately, but their Forces make up a compound Motion, which at New and Full *Moon* is greateſt, and leaſt at the *Quadratures*, and theſe effects are variouſly limited by the different Diſtances of theſe *Luminaries* from the Earth, their *Declinations* from the *Æquator*, the various *Latitudes* of Places, and alſo the different Situation of the *Shores*, *Banks* and *Bays* of the *Sea*. By this Gravitation, Bodies

on this Globe will press towards its Center, tho' not exactly thither neither, by reason of the *oblate spheroidical* Figure of the Earth arising from its diurnal Rotation about its Axis. Thus we see this one Principle will account for all the great and constant Appearances of Nature, and none but this will exactly answer any one, much less them all, which is a Demonstration of its Truth. And were not our Terrestrial *Physiology* more complicated than the Celestial, (by reason of the multiplicity of different Attractions proceeding from the many different Bodies that surround any particular one) we should doubtless see the Extent of this Principle, in accounting for the more minute, and less constant appearances on this our Globe, as in a great many we actually are. Add to these Considerations, that we are certain by the Effects, that the Gravitation by which the *Planets* are kept in their Orbits, and by which the *Moon* turns round the Earth, is of the same Nature with that by which heavy Bodies tend toward the Center of the Earth. In the *Moon* the Case is plain, for since the *Rectilinear* Spaces, describ'd by falling Bodies in the beginnings of their Motions, from whatever Motive Powers they be urg'd or drawn, are *proportional* to these Powers. The *Centripetal* Forces of the *Moon* revolving in its *Orbit*, will be to the Force of Gravity on the Surface of the Earth, as the Space the *Moon* describes in descending towards the

the Earth, by its *Centripetal* Force, in a ſmall portion of time, if it were ſuppos'd depriv'd then of *Circular* Motion, to the Space, a heavy Body wou'd deſcribe in the ſame time by its own Gravity, near the Surface of the Earth. The firſt of theſe Spaces, is equal to the *verſed Sine* of the *Arch* deſcrib'd by the *Moon* in that time, for that is the Meaſure of the Tranſlation of the *Moon* out of its *Tangent*, by this *Centripetal* Power, which may be computed from the time of its *Periodical* Revolution, and its Diſtance from the *Center* of the Earth being given. The other Space is evident from the Experiments on *Pendulum's*; and when the juſt Calculation is made from theſe Principles, the firſt Space to the ſecond, or the *Centripetal* Force of the *Moon* revolving in its Orbit, to the Force of Gravity on the Surface of the Earth, will be found as the *Square* of the *Semidiameter* of the Earth, to the *Square* of the *Semidiameter* of the *Moon's* Orbit. But in the former part of the Section it has been ſhown, that the *Centripetal* Force of all the *Planets*, was reciprocally as the *Squares* of their Diſtances. Therefore the *Centripetal* Force of the *Moon* near the Earth's Surface, is equal to the Force of Gravity, and conſequently it is the ſame Force in both; for were they different Forces, Bodies by the united Forces of the *Moon* and Earth, wou'd fall with double the Velocity they now do: It is plain then, that the *Centripetal* Force whereby

whereby the *Moon* is drawn out of its *Tangent*, is the very same Terrestrial Gravity (whereby Bodies descend near the Earth,) which reaches to the *Moon*; and since the Revolutions of the *primary Planets* about the *Sun*, and of the *secondary Planets* about their primary Ones, are Appearances of the same Nature with that of the *Moon* about the Earth, since it has been shown that the *Centripetal* Forces of the primary *Planets* are directed towards the *Sun*, and the *Centripetal* Forces of the secondary *Planets* towards their primary Ones, as the *Moon's* is towards the Earth; Lastly, Since all their *Centripetal* Forces are reciprocally as the Squares of their Distances, we must conclude the Natures of their Gravitation to be the same in them all, and that they all Gravitate towards one another. For since Action and Reaction is mutual, and since the *primary Planets* gravitate towards the *Sun*, as also the *secondary Planets* tend toward the Primary ones as the Center of their Motions; and since the Decrease and Increase of this Gravitation, is of the same Nature with that of our Terrestrial Gravity; since likewise the *Sun* disturbs the Motion of the *Moon*, and the *Sun* and *Moon* those of our *Earth*, it is plain they all, *Sun*, *Moon*, *Planets* and their *Satellits*, mutually gravitate upon one another.

§ XXVI. Having thus in the General, establish'd the *Laws of Nature*, and deduc'd such Consequences from 'em as we found necessary

to

to clear ſome Parts of the following Diſcourſes; having likewiſe ſhown the Neceſſity of admitting the Univerſal Law of *Gravitation* to ſolve the Celeſtial Appearances, and hinted the great Uſe of this Principle in the Celeſtial *Phyſiology*, let us next proceed to ſome of the moſt *Univerſal* of our Terreſtial *Phænomena*; and firſt of all, let us enquire into the Nature and Cauſe of Fluidity, which ſeems to conſiſt principally in the *Mobility* of ſome parts, without carrying along with 'em the reſt, or the eaſie ſlipping of ſome Parts upon others unmov'd, at leaſt, not mov'd after the manner of ſolid Bodies. All the Bodies in the Univerſe are Originally compounded of ſolid Parts, tho' not indiviſible, yet very ſmall and firm; and Fluids muſt neceſſary take in theſe four Conditions. 1. That their Parts be extremely little; in our common Fluids it is certain that no Eye, however aſſiſted, has been able to perceive their Magnitude; we have been able to diſcover the Figures of Bodies ſwimming in Fluids, but no one as yet has been able to diſtinguiſh the *Figures* or *Magnitudes* of the conſtituent Parts of *Liquors*. 2. That their Figures be *ſpherical*, or at leaſt *ſpheroidical* or approaching to one of theſe, ſo that they may touch only in a Point, and by conſequence, one Particle may eaſily ſlip upon another, and for that End, 3. They muſt be exactly ſmooth and poliſh'd, and ſubjected to the Univerſal Law of

Gravita-

Gravitation, whereby each Particle of the Fluid attracts another, whence that cohesion in the Parts of the finest natural Fluids proceeds; but their Gravity must be such, that the Force thereof may easily exceed the Force of their Cohesion; and here we are to distinguish between these Fluids, generated by the Force of the Fire, and those that are naturally such, there being no necessity of attributing any particular Figure to the Parts of the first Kind, which owe their Fluidity to the Force of the Particles of Fire, which tear asunder the Parts of solid Bodies, and keep 'em in a perpetual Agitation, and thereby make 'em appear in the Form of a Fluid; whereas the Appearances of natural Fluids do necessarily require the Conditions in their Parts just now assign'd. 4. The Particles of natural Fluids must be similar, of equal *Diameters*, of equal Solidity, and consequently of equal specifick Gravities, or at least they must not widely differ one from another in these Qualities, that the Fluid may be *Homogeneous*, and of the same uniform Nature; from these general Suppositions, all the general Appearances may be easily accounted for.

§ XXVII. Water seems to consist of small, smooth, hard, porous, spherical Particles of equal *Diameters*, and equal specifick Gravities, which have between 'em some Spaces so large, and ranged in such a manner, as to be pervious on all

all Sides. Their Smoothneſs makes 'em ſlip eaſily upon one another; their *Sphericity* keeps 'em from touching one another in more Points than one, by both which, their Fricſtions in ſliding upon one another is rendered the leaſt poſſible; their Hardneſs is the reaſon why Water is incompreſſible, when the Air lodg'd in it is exhauſted.

§ XXVIII. The *Poroſity* of the Particles of Water (which is ſo great, that a *Cubical* meaſure of Water contains at leaſt forty times more Pores than Parts; for Water is nineteen times lighter than Gold, and conſequently nineteen times rarer than Gold; and Gold will by much preſſure, let Water paſs through it, and ſo may be ſuppoſed to have more Pores than ſolid Parts) accounts not only for the different *Specifick* Gravity between Water and other Fluids, ſuch as *Mercury*; but alſo for its greater Tranſparency than moſt other Fluids, the *Rays* of Light finding an eaſy admittance on all Hands through its pervious Pores, and it ſuggeſts the Reaſon alſo why it is more eaſily concreted into a ſolid Form than other Fluids are *Cold* and *Freezing*, ſeem to proceed from ſome *Salin* Subſtance floating in the Air; we ſee that all Salts, but more eminently ſome, mix'd with Ice, prodigiouſly encreaſe the Effects and Force of Cold, we ſee all *Salin* Bodies produce a Rigidity and Stiffneſs in the Parts of Bodies to which they are apply'd, much like the Effects of Freezing;

we

we know from Mr. *Boyle's History of Cold*, that Freezing increases the Dimensions both of Solid and Fluid Bodies; *Microscopial Observations* inform us, that the Figures of some Salts, before they shoot into Masses, are thin double wedg'd like Particles, which have abundance of Surfaces in respect of their Solidity, which is the reason why they swim in Water when they are rais'd once, tho' they be specifically heavier. But this Effect may be more justly attributed to the same Cause that is presently to be shown to be the Cause of Freezing, *viz.* to the small Points of the Salts getting into the Pores of the Particles of Water, whereby these Salts are suspended in the Water. In Summer, the Heat of the Sun dissolves the *Salin* Particles into a Fluid, breaks off their slender Points, and by its Action, keeps 'em in a perpetual Motion, so that they cannot shoot into a solid Wedge, and consequently are not able to produce the *Appearances* of *Cold* upon Bodies; but in Winter they are less disturb'd, and more at liberty to approach one another; and by shooting into those *Chrystals* (as we see the Particles of artificial Salts do, when the Liquor is expos'd to the Air) which by both their Extremities, insinuating themselves into the Pores of Particles of Water, make 'em cohere, and fix 'em in a solid Form. The Dimensions of freez'd Bodies are encreas'd by the Insinuations of these *Chrystal* Wedges in their Pores, and the

Particles

Particles of congeal'd Water are kept at ſome diſtance from one another, by the Figure of theſe *Chryſtals*, which in Freezing, inſinuate themſelves in their Pores; for as I have before ſaid, theſe *Chryſtals* are obſerv'd to have the Form of a double Wedge, whoſe Extremities are pointed and ſlender, but its Middle broader and larger, ſo that when the Extremities have inſinuated themſelves into the Pores of two watery Particles, theſe *Globules* cannot come to touch, by reaſon of the Largeneſs of the Middle of theſe *Chryſtals*, and ſo theſe Particles in Freezing, are kept at greater Diſtances from one another, than they were when in a fluid Form; and thus the Spaces between theſe ſpherical Particles, become larger and wider than before, which is one Reaſon why Ice becomes *ſpecifically* lighter than Water. But beſides this, there are many little *Volumes* of Air included at ſeveral Diſtances, both in the Pores of the watery Particles, and in the Interſtices form'd by their ſpherical Figures. Now by the Inſinuation of theſe *Chryſtals*, the *Volumes* of Air are driv'n out of the watery Particles, and many of 'em uniting form larger *Volumes*, which thereby have a greater Force to expand themſelves than when diſperſed, and ſo both enlarge the Dimenſions, and leſſen the *ſpecifick* Gravity of Water thus congeal'd into Ice. Hence we may gueſs at the manner, how Water impregnated with *Salts*, *Earths* or *Sulphurs*, which

are

are not easily dissolvible, may form itself into *Mettals*, *Minerals*, *Gems*, and other *Fossils*, the Parts of these Mixtures becoming a Cement to the Particles of Water, or getting into their Pores, change 'em into these different Substances.

## *Corollary.*

Hence it is plain, that the Quantity of Water on this our *Globe* does daily decrease, some part thereof being every Day turn'd into *Animal*, *Vegetable*, *Mineral*, or *Metallick* Substances, which are not easily dissolv'd into their component Parts again; for separate a few Particles of any Fluid, and fasten them to a solid Body, or keep 'em asunder from one another, and they are no more fluid, to produce which, a considerable number of these Particles are necessarily required.

§ XXIX. *Mercury* seems to consist of exceeding small, smooth, solid, spherical or *spheroidical* Particles; for since *Mercury* in ever so small Quantities is absolutely opake, and lets none of the Rays of Light pass; and since, whatever be the Cause of Reflexion and Refraction, Light being Material, must either make or find a Passage through every refracting *Medium*; since likewise it is probable, that Light does not penetrate through the solid Substance of the constituent Particles of Fluids, but rather

rather through their Pores and the Vacuities form'd by their Orbicular Figures, it's plain therefore, that the Particles of *Mercury* have very few Pores, and if they be *Spherical*, that their Diameters are not much greater than thoſe of the Particles of Light, for theſe Interſtices are as the Cubes of the Diameters of the *Globules*, by whoſe meeting they are form'd; and ſeeing Light cannot paſs through theſe Interſtices, it is plain, that the Diameters of the Corpuſcles of *Mercury* muſt not be much greater than thoſe of Light; and if theſe Corpuſcles be *Spheriodical*, or Oval, their ſhorteſt Diameters muſt not be much greater than the Diameters of the Particles of Light, to form Paſſages for it. The Solidity of the Particles whereof *Mercury* conſiſts, and the ſmallneſs of the Interſtices they leave between them, accounts for that wonderful Gravity of *Mercury*, above other Fluids.

§ XXX. *Air* ſeems to conſiſt of *Spires* contorted into ſmall Spheres, through the Interſtices of which, the Particles of *Light* may freely paſs, and this is the Reaſon why it is ſo light, the ſolid Subſtance of the *Spires* being very ſmall in proportion to the Spaces they take up; their being ſpiral, accounts for the elaſticity of Air; their being ſpherical Particles which gives free Paſſage to any Heterogeneous Matter, accounts for Air's being compreſſible, as alſo how when compreſs'd it retains

its fluidity, because spiral Spheres, through which another Matter freely passes, when compress'd, form themselves into *Spheroids*, or Figures most resembling them. This Account of the properties of *Air*, may perhaps please some; but there is another, which to others seems the more genuine; for, if *Air* be suppos'd to consist of small Particles, which endeavour to recede from one another, with a Force *reciprocally proportional* to the Distances betwixt their Centers; all the Appearances of *Air* may thence be accounted for; for upon this *Hypothesis* they will compose an *Elastick Fluid*, whose *Density* is proportional to its *Compression*, as Sir *Isaac Newton* has demonstrated; *Prop.* 23. *Pag.* 270. *2d Edit.* The *Diameters* of the Particles of *Air* seem to be greater than those of *Water*; and the *Diameters* of the Particles of *Water*, greater then those of *Mercury*; and that of the *Light*, by far the least of all, as shall be afterwards shown.

§ XXXI. Other Fluids (besides that of the *Light*, under which Name I comprehend all that which passes under the Name of *Ætherial* or *Subtile Matter*, which I shall examine hereafter) seem to be compounded of these *Primitive Fluids*, viz. *Water*, *Air*, *Mercury* and *Light*; and of Particles of *Salts*, *Earths*, *Sulphurs*, and such like Ingredients, and the Varieties of such mixt Fluids may in the general be thus estimated. 1. Supposing all other things alike,

alike, eſpecially the *Primitive Fluid*, and the Figure of the parts of the Ingredient, the mixt Fluids will differ proportionably to the Magnitude of the parts of the ſolid Body, which mixes with the Fluid; thus Water or *Lymph* mix'd with *Globules* of Fleſh or Blood of a greater *Diameter*, will make a different Liquor from the ſame *Lymph*, mix'd with *Globules* of Fleſh or Blood of a leſs *Diameter*. 2. *Cæteris Paribus*, (eſpecially the Fluid, the Figure, and the Diameters of the mixing Ingredient being the ſame,) the Liquor will differ proportionably to the Difference of the Firmneſs or Softneſs of the Parts of the mixing Ingredient; thus *Mercury* mix'd with *Globules* of *Diamond*, would make a different Fluid from *Mercury* mix'd with *Globules* of Silver or Braſs. 3. All other things being ſuppos'd the ſame, the Fluid will differ proportionably to the Difference of the ſpecifick Gravities of the Particles of the mixing Ingredients; thus a mixture of *Gold* and *Mercury* will make a different Liquor from that of *Mercury* and *Lead*, the Difference of the ſpecifick Gravities being here only conſidered. 4. All other things being ſuppos'd the ſame, the Liquor will differ according to the different Degrees of the Coheſion of the ſolid Parts among themſelves; thus, *Mercury* mix'd with little ſpherical *Magnets*, will make a different mixture from that of *Mercury* mixt with little Spheres of *Lead* or *Iron*. And theſe ſeem

to be the *Primogenial* Differences of mixt Fluids; now, not only all these may be differently combin'd with one another, and with the four *Primitive Fluids*, but also the Figures of the solid Parts in the mixture may be infinitely diversified, (whereas we have hitherto only suppos'd all the mixing Solids *Spherical*) which will make an infinitely infinite Variety of mixt Liquors.

§ XXXII. That *Light* is a Body, or a material Substance, seems to be evident from these Considerations. 1. It is progressive, and requires a determin'd time to go from one place to another, and is not propagated in an Instant, as is plain from Mr. *Romer*'s Reasonings upon the *Eclipses* of the *Satellits* of *Jupiter*, (which are confirm'd by the Observations of other *Astronomers*) whereby he demonstrates, that *Light* requires about ten Minutes to come from the *Sun* to us. 2. It may be stopt or resisted in its Passage from one place to another, by the Interposition of an opake Body, as other Fluids are stopt in their Courses by the Opposition of any solid Body. 3. It may be congregated within a narrower, or scattered thro' a larger Space, as is evident from reflecting *Specula*, and refracting *Burning-Glasses*. 4. It may be reflected, and the Determination of its Motion changed like other Bodies, and it observes the same Law in its Reflexions that other Bodies do, *viz.* the *Angle* of Reflexion

is

is always equal to the *Angle* of Incidence. 5. It may be put out of its Courſe more or leſs, according to the Nature of the *Medium* through which it paſſes. 6. It acts upon the *Organs* of *Animals*, and upon all other Bodies, as other fluid Subſtances do, by ſtriking upon them with a determin'd Force, by communicating a certain Degree of Motion to them, by ſeparating their component Parts, and putting them in Motion; all theſe Effects we daily ſee. 7. It may be confin'd and ſhut up in determin'd Spaces like other Fluids. The Light of the *Sun* will warm and heat other ſolid and fluid Bodies, which Effects, continue when their Cauſe is remov'd; the parts of Light are yearly impriſon'd in Fruits, Plants, and other Vegetables, as we ſee by the Spirits and warm Juices they afford. 8. Laſtly, The parts of Light are endow'd with various *Original Colours*, ſome are *Red*, others *Blue*, others *Yellow*, and ſome *Green*, as Sir *Iſaac Newton* has demonſtrated, and may be ſeen by a *Priſm* applied to the Hole of a darken'd Room through which the *Sun* ſhines. Now all theſe are the Properties of Bodies, and can belong to nothing but Material Subſtances.

§ XXXIII. That the Particles of *Light* are extremely little or ſmall, we may conclude from thence, that they paſs through almoſt all Bodies that are pervious, ſuch as *Chryſtals*, *Glaſſes*, ſeveral *Gems*, and almoſt all Fluids but

*Mercury*; and that it freely passes where no other Fluid, how thin soever, can enter, and yet, no Eye, however assisted, has been able to discover or distinguish the parts of the grossest Fluid. But what most of all demonstrates their smallness, is, that Light may be propagated from innumerable different *Luminous Bodies*, without any considerable opposition to one another; suppose a Plate of Mettal (having at the top the smallest Hole can be made) were erected *perpendicularly* upon a *Horizontal Plane*, and about it were set innumerable luminous Objects of about the same height with the Plate, at an ordinary Distance from it, the Light proceeding from every one of those Objects, will be propagated through this small Hole, without interfering. This will appear by applying a dark Object in a straight Line against the Luminous Body, for the Light of this Body will through the Hole be receiv'd upon the dark Body: Now it is impossible that so many different *Streams of Light* cou'd be transmitted through so small a Hole, were not the Particles of Light extremely small. Add to this, that were not the Particles of Light extremely little, being extremely swift, (*i. e.* more than a Million of times swifter than a *Cannon Bullet*, continuing in its greatest Velocity, as shall be presently shown) they wou'd peirce all kinds of solid Bodies with almost as great Facility as they do Vacuities, whereas we see Light regularly

gularly reflected from ſome Bodies. Moreover, we find that innumerable different Spheres of Light within our *Horizon*, may be propagated from their ſeveral luminous Centers, without interfering. How many Millions of Candles and *Flambeaux* may we ſee ſending out their *Tides* of Light, without claſhing upon one another, which argues both the Smallneſs of the Parts of Light, and the Largeneſs of the void Interſtices between the Particles of Air and other Bodies.

§ XXXIV. How extremely ſwift the Particles of *Light* are, we may gather from the forementioned Experiment of Mr. *Romer*'s, whereby he demonſtrates, that the *Streams* of *Light* paſs from the *Sun* to our *Earth* in about ten Minutes; and *Hugens* in his *Coſmotheoros*, has prov'd, that a *Bullet* continuing in the Velocity with which it leaves the Muſle of the *Cannon*, wou'd require twenty five Years to paſs from us to the *Sun*: Now the *Via Percurſa* being the ſame in both, the Velocities will be reciprocally as the times, *i. e.* the Velocity of Light will be to that of a *Cannon-Bullet*, perſiſting in its greateſt ſwiftneſs, as twenty five Years is to ten Minutes; or as 1314700 to one *Proxime*, ſo that the Velocity, with which the Particles of Light paſs, will be more than a Million of times ſwifter than a *Cannon-Bullet*. Moreover, the Diſtance betwixt the *Sun* and *us*, is at leaſt 12000 *Diameters*

*meters* of the Earth, but allowing it to be only 10000 *Diameters*, the Light runs a thousand *Diameters* in a Minute, or sixteen and half Diameters of the Earth in a Second, or beating of an Artery, that is more than 1100000 *Toises*, since the *Diameter* of the Earth contains 2865 *French Leagues*; and every *League* contains 2282 *Toises*, according to the Numbers of Mr. *Picard*. But Sound goes but about 180 *Toises* in a Second, wherefore Light is about six hundred thousand times more Swift than Sound. Likewise, since the Earth's middle *Diameter* is 7846 Miles, each of which contains 5000 Feet; and since Light goes in a Second or in a pulse of an Artery, sixteen and a half *Diameters* of the Earth, it is plain, that in every Second it runs at least a hundred and thirty thousand Miles, which is a prodigious and almost an incredible Space in so short a time. But the extraordinary Effects of Light and Heat, seem to require all this; we see how powerfully it acts (being congregated) upon the most compact solid Bodies, and we never perceive any diminution of its Force arising from an abatement of its Velocity.

§ XXXV. The *Sun* and fixt *Stars* seem to be huge, dense Bodies (like the *Earth* or *Planets*) heated to an extraordinary Degree, and their Heat probably may be preserv'd by the greatness of their Bodies, and the mutual Action and Re-action between their Parts, and the

Light

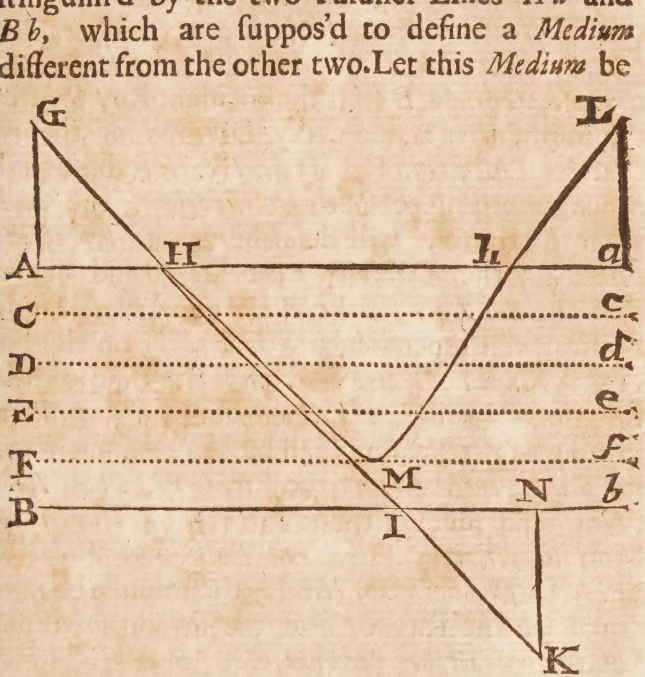
Light which they emit; and their Parts are kept from fumeing away by their *fixity*, and alſo by vaſt Weight and Denſity of the *Atmoſpheres* incumbent upon them, and powerfully compreſſing them, and condenſing the Vapours and Exhalations which ariſe from them. The beſt *Image* we can frame to our ſelves of the *Sun*, is to conceive the Body of the *Sun*, and the *Fluid of Light* ſeparated and apart, (and it is highly probable they may be actually ſeparated, and the firſt intirely drain'd of the latter) the *Sun* then will be like a great *Earth*, only more Denſe, Compact, and Solid. The *Fluid of Light*, like that of *Water* or *Air*, but infinitely more ſubtile, active, and of finer Parts; and that (in compounding them again) the firſt has been ſaturated with, or quite ſwallow'd up in the latter, by which the Parts of the firſt has been put in ſtrong, quick and vehement Vibrations. When the *Sun* and *fixt Stars* are thus diſſolv'd and drench'd in this Fluid, the Light will be emitted from them by the vibrating Motion of their Parts, after the manner we ſee Iron, when heated to ſuch a Degree, as to be juſt going into Fuſion, by the vibrating Motion of its Parts, ſend forth with Force and Violence, copious Streams of liquid Fire all around: great Bodies preſerve their Heat longeſt, and that perhaps in proportion to their *Diameters*. Sir *Iſaac Newton* has made it probable, that the *Comet* which appear'd in 1680, by approach-

ing

ing to the *Sun* in its *Perihelium*, acquir'd such a Degree of Heat, as to be 50000 Years a cooling, whence we may guess, that supposing the *Sun* and fixt *Stars* to be only *Collections* of dense and solid Matter like the *Planets*, heated to a very intense Degree, they may be many Millions of Years without losing any considerable part of their Heat. *Astronomers* have observ'd a close, compact and large *Atmosphere* about the *Sun*, and there is no doubt to be made, that its Body is of the same Nature with the other material Parts of this Universe, excepting what Alterations its vehement Heat may produce, and consequently, its highly probable, that the *Sun* and *fixt Stars* are only *Planet*-like Bodies, vehemently heated.

§ XXXVI. *Bodies* and *Light*, act mutually upon one another, *i. e. Bodies* act upon *Light*, in emitting reflecting, refracting and bending its Rays, and *Light* upon *Bodies*, in heating them, and putting their Parts in a vibrating Motion, wherein Heat consists, according to Sir *Isaac Newton*'s Discoveries. If we suppose that *Bodies* act upon *Light*, by attracting it in Lines *perpendicular* to their Surfaces, *i. e.* supposing two similar *Mediums* distinguished by *Parallel* Lines, and that a Ray in its Passage out of the one through the other, is urged *perpendicularly* towards either Plane, by any Force, which at given Distances from the Plane, is of given Quantities; then whatever Inclinations the

the Rays have to the Plane of *Incidence*, the Sine of the *Angle* of *Incidence* of every Ray considered apart, shall have to the Sine of the *Angle* of *Refraction* a constant *ratio*: In the following *Scheme*, let the similar *Mediums* be distinguish'd by the two Parallel Lines *A a* and *B b*, which are suppos'd to define a *Medium* different from the other two. Let this *Medium* be




divided by parallel pointed Lines *C c*, *D d*, *E e*, *F f*, into similar Planes. Let *G H* be the *incident* Ray. And suppose the *refracting Medium A a*, *B b*, begins to act upon it, either when it enters into it at *H*, or at some certain Distance from it on the one side, and ends at a certain

Distance

Distance from it on the other; and that at all Places between these two Limits, the *refracting* Plane acts upon the Ray in Lines whose Direction is *perpendicular* to that Plane; and that the Actions upon the Ray at equal Distances from the refracting Plane, be equal; and at unequal ones, either equal or unequal, at any *Rate* whatever. If the Impulse of the *refracting Medium A a B b* on the incident Ray *G H* be uniform, that is, at every Division of the *refracting Medium*, *C c*, *D d*, *E e*, *F f*, be equal, then according to *Galilæus*'s *Problem*, the *incident* Ray *G H*, will describe in the *refracting Medium*, the *Parabolic Curve G I*, and be *refracted* into *I K*. Take *A H*, equal to *I N*, and erect the Perpendiculars *G A*, *K N* on the Parallel Planes *A a* and *B b*, and the Sine of the Angle of Incidence *G A*, and *K N* the Sine of the Angle of Reflexion, shall be in a constant *Ratio* in all the *Incidences* of the Ray *G H*, as Sir *Isaac Newton* has demonstrated in *Prop.* 94. *Page* 203. and *seq. Princip. Phil. 2d Edit.* and *Prop.* 6. *Pag. Latin Ed. Optic.* And if the Impulse be unequal on the Ray *G H* at the several Divisions of the *refracting Medium C c*, *D d*, *E e*, *F f*, yet since it must be uniform through every single Division, if these be suppos'd infinitely little and many, the Proposition will still hold true, whatever be the Law of the Attraction of the Ray, provided its Direction be Perpendicular to the Plane of the *refracting Medium*

and

and equal, at equal Distances from it. And since by the 2d *Corollary* of the 3d *Law of Nature*, the oblique Force of the incident Ray *G H*, may be divided into the two Forces *G A* and *A H*, and of the *refracted* Ray *I K*, into *K N* and *I N*; it is evident, that the Velocity of the Ray before its *Incidence*, is to its Velocity after it Emerges; as the *Sine* of *Emergence K N*, to the *Sine* of *Incidence*, *G A*. And if the Velocity of the Ray before its Incidence be greater than afterwards, that is, if the Obliquity of the *Incident* Ray be very Great, in respect of that of the *Refraction* when it has enter'd the *Refracting Medium A a B b*, then the *Parabolick* Line will turn back toward the Plane of Incidence; because in that Case, the Sine of *Emergence* will grow larger and larger, till it become equal to the *Radius*, and then the *Ray* must return somewhere at *M* in the *Parabolick* Line *A H m h L*. Take *h a* equal to *H A*, and erect the Perpendicular *a L*, and it shall be equal to *A G*, that is, the Sine of *Incidence* shall be equal to the Sine of Reflexion, as Sir *Isaac Newton* has prov'd in the forecited Place of his Principle. Now since it is matter of Fact and Experiment, that the *Sines* of the *Angles* of *Incidence*, and *Refraction* in all Rays of whatever Nature, observe a constant *ratio*, and that the *Angles* of *Reflexion* and *Incidence* are equal; it is therefore on the other hand true, that the Rays of *Light* are thus urg'd by the *Refracting Media*,

*Media*, and their Velocity thus abated by *reflecting* ones, so that it is evident, *Refraction* and *Reflection* proceed from one and the same Principle, acting differently in different Circumstances, that is, when the Obliqnity of the *Incident* Ray is great, and the *Refractive* Power of the *Medium* is also considerable, the Ray will be reflected. But if its Angle of *Incidence* be large, and the *Refractive* Power of the *Medium*, not very strong to throw it far from the Perpendicular, it will be *Refracted*.

℣ XXXVII. Sir *Isaac Newton* has demonstrated from plain and convincing Experiments, that the *Light* of the *Sun* consists of Rays differently *refrangible* and *reflexible*, and that those Rays are differently *reflexible*, that are differently *refrangible*. These Rays that are all alike *refrangible*, he calls the *Light* of them Simple and *Homogeneal*, and those that are some more *refrangible* than others, he calls their *Light*, Compound and *Heterogeneal*; the greater or less *Refrangibility* of Rays, is their Disposition to be turn'd more or less out of their way, in like Incidences on the same *Medium*; and their greater or less *Reflexibility* is their Disposition to be return'd back more or less easily into the same *Medium* from any other, upon whose Surface they fall. *Refraction* out of the Rarer *Medium* into the Denser is made so, that the *Angle* of *Refraction* is less than the *Angle* of *Incidence*, and on the contrary. The Colours of

*Homo-*

*Homogeneal Light* are theſe, *Violet, Indico, Blue, Green, Yellow, Orange* and *Red.* Theſe Colours in the Objects are their Diſpoſition to *reflect* this or that ſort of Rays more copiouſly than the reſt; and in the Rays of *Light* they are their Diſpoſition to propagate this or that Motion into the *Organs* of Viſion, and in *them,* they are Senſations of thoſe Motions under the Forms of Colours; the Rays that produce Red Colours, are leaſt *refrangible,* and thoſe that make Violet, the moſt, and the reſt are more or leſs *refrangible,* as they approach either of theſe Extremes in the Order ſet down, that is, Orange is leaſt *refrangible,* next to Red, and Yellow next to Orange, and ſo on. All the Colours of the Univerſe which are made by Light, are either the Colours of *Homogeneal* Lights, or compounded of a Mixture of thoſe: Whiteneſs is produc'd by a due Mixture of all the *Primary* Colours of *Homogeneal* Light; and Blackneſs by a Suffocation, or *Non-reflexibility* of Light; and all Grey Colours, betwixt Black and White, may be compounded of all the *Primary* Colours mixt in a due Proportion; the *Primary* Colours of *Homogeneal* Light are unchangeable in their Nature, and no *Reflexions* nor *Refractions* will change any of theſe into another; whereas by the due Mixture of colour'd Bodies, Colours may be produc'd by Compoſition, which ſhall be like to the Colours of *Homogeneal* Light, but not as to the immu-

immutability of Colour; for that may be chang'd according to the Colour of the Light by which they are seen; so that if the *Sun*'s Light consisted but of one sort of Rays, there wou'd be but one Colour in the whole World, and it wou'd be impossible to produce any new Colour by *Reflexions* or *Refractions*, for all the Variety of Colours depends upon the different Composition of Light.

§ XXXVIII. The Rays of Light which fall upon Bodies, and are *reflected* or *refracted*, begin to bend before they arrive at the Bodies. Sir *Isaac Newton* has shown by several Experiments of Rays passing by the Edges of Bodies, that they are *incurvated* by the Action of these Bodies as they pass by them, and that this Action is strongest at the least Distance; he has demonstrated likewise, that the Cause of *Reflexion* is not the impinging of Light on the solid and impervious Parts of Bodies. For (not to repeat those other Arguments which he has brought in great plenty) since Glass can be no other ways polish'd, than by grating and scratching it by Substances, whose Parts are small and subtile, so that the Scratches and Frettings of its Surface become too small to be visible, yet not so small as to become truly plain or *spherical*, and all together to compose one Surface; if Light were *reflected* by impinging upon the solid Parts of Glass, it wou'd be scatter'd as much by the most polish'd Glass, as by the rougheſt,

rougheſt, which being contrary to Experience, it is evident, that the Reflexion of a Ray is not effected by one ſingle Point of the *reflecting* Body, but by ſome Power of the Body, which is evenly diffus'd over all its Surface, by which it acts upon the Ray without immediate *Contact*, after the manner hinted § 37, Bodies *reflect* and *refract* Light by one and the ſame Power variouſly exerciſed in various Circumſtances; for when Light goes out of Glaſs into Air as *obliquely* as it can poſſibly do, if its *Incidence* then be made ſtill more *oblique*, it becomes totally *reflected*, for then its *refractive* Power, or the Force of its Attraction upon the Ray, becomes too ſtrong to let any of the Rays go through. Beſides that, thoſe Surfaces of tranſparent Bodies which have the greateſt *refracting* Power, *reflect* the greateſt quantity of Light; for by Experiment it is found, that in the *Superficies* interceding two tranſparent *Mediums*, the *Reflexion* is ſtronger or weaker, as the Superfice hath a greater or leſſer *refracting* Power; for in the confine of *Air* and *Sal-Gem* 'tis ſtronger than in the confine of *Air* and *Water*, and ſtill ſtronger in the confine of *Air* and *common Glaſs* or *Cryſtal*, and ſtronger in the confine of *Air* and *Diamond*. Between the Parts of opake and colour'd Bodies, there are many Spaces either empty or repleniſh'd with *Mediums* of other Denſities, as Water between the tinging Particles wherewith any Liquor

is impregnated, Air between the *aqueous Globules*, that constitute Clouds or Mists, and perhaps, *Mediums* different from both these between the Parts of hard Bodies. Now *Reflexions* are produced in the *Superficies* which intercede these *Mediums* of different Densities, and the Reason why uniform pellucid *Mediums* have no sensible Reflexion but at their external *Superficies*, is because all their Parts are of an equal Density; and Opacity arises from the multitude of *Reflections* produc'd in the internal Parts of Bodies.

§ XXXIX. All Bodies seem to have their *refractive* Powers *proportional* to their Densities, excepting so far as they partake more or less of sulphurous, oily Particles, and thereby have their refractive Power made more or less; this Sir *Isaac Newton* has found by Observation on almost all transparent Bodies, together with a Calculation founded upon the Supposition, that Light is swifter in Bodies than *in vacuo*, in the Proportion of the *Sines* which measure the *Refraction* of Bodies, which is certainly true, since it's from the Action of Bodies on Light, that this *refractive* Power does arise; and it's very probable, that this *refractive* Power in Bodies does mostly depend upon the sulphurous Parts with which they abound, since all Bodies partake more or less of Sulphurs, as by Chymical *Analyses* we find. And as Light congregated by a Burning-Glass, acts most upon sulphurous Bodies, to turn them into Fire and Flame; so since

ſince all Action is mutual, Sulphurs act moſt upon Light: and that the Action between Light and Bodies is mutual, is evident from this Conſideration, that the denſeſt Bodies which *refract* and *reflect* Light moſt ſtrongly, grow hotteſt in the Summer Heat, by the Action of the *refracted* and *reflected* Light. The Bodies that reflect Light, are thoſe whoſe Pores are fill'd with *Mediums* of an unequal Denſity with that of the *refracting Medium* it ſelf, and Bodies become more tranſparent, by filling their Pores with Fluids of equal, or almoſt equal Denſities with their Parts, as Paper dip'd in Water or Oyl: and on the contrary, the moſt tranſparent Subſtances may, by evacuating their Pores, or ſeparating their Parts, be render'd ſufficiently opake, as Salts or wet Paper dry'd, Glaſs by being pulveriz'd, or Horn by being ſcrap'd.

§ XL. The *leaſt Parts* of almoſt all Natural Bodies are tranſparent, as may be ſeen by viewing ſmall Bodies with a *Microſcope*, and conſequently, they muſt, according to their ſeveral Sizes, reflect Rays of one Colour, and tranſmit thoſe of another, upon the ſame Ground that thin Plates reflect or tranſmit thoſe Rays; for a thin Plate of an even thickneſs appears all over of the ſame Colour, and if this Plate were ſlit into *Threads*, or broken into *Fragments* of the ſame thickneſs with the Plate, there is no reaſon why every *Thread* or *Frag-*

*ment* ſhould not keep its Colour, and conſequently, why a heap of thoſe *Threads* or *Fragments* ſhould not conſtitute a Maſs or Powder of the ſame Colour which the Plate exhibited before it was broken; and the ſmall Parts of all Natural Bodies being like ſo many *Fragments* of a Plate, muſt on the ſame Grounds exhibit their Colours. Now Sir *Iſaac Newton* found by Obſervation, that thin Plates or Bubbles *reflected* Rays of one Colour and *tranſmitted* thoſe of another, according to their ſeveral thickneſs or thinneſs; and therefore the ſmall Parts of Natural Bodies being tranſparent, muſt upon the ſame Grounds *reflect* or *tranſmit* the ſeveral ſorts of Rays: and this is the Foundation of the various Colours of all Natural Bodies. But the parts of Bodies on which their Colours depend, muſt be denſer than the *Medium*, which pervades their Interſtices; and as there is a conſtant Relation between Colours and *Refrangibility*, the moſt *Refrangible* Rays being *Violet*, the leaſt *Refrangible Red*, and thoſe of intermediate Colours having proportionally intermediate Degrees of *Refrangibility*; ſo there is a conſtant Relation between Colour and *Reflexibity*, the *Violet* being in like Circumſtances reflected at leaſt thickneſſes of any Plate or Bubble, the Red at greateſt thickneſſes, and the intermediate Colours at intermediate thickneſſes; and there are ſeveral Orders of thoſe Colours more or leſs intenſe and vivid, according

to

to the ſeveral thickneſſes of theſe Plates or Bubbles: and the reaſon why the Surfaces of all thick and tranſparent Bodies reflect part of the Light incident on them, and refract or tranſmit the reſt, is, that ſome Rays at their *Incidence* are in *Fits* of eaſie *Reflection*, and others in *Fits* of eaſie *Tranſmiſſion*. Thoſe who deſire full Satisfaction in this wonderful Appearance of Nature, muſt go to that late admirable Treatiſe of *Opticks*, written by Sir *Iſaac Newton*; for it is impoſſible to ſeparate the Parts of this Work from one another without Diſadvantage to them, or to ſum them up in a leſs room, without loſing ſomething *New* and *Uſeful*. That great Perſon having before ſhown how far *Numbers* and *Geometry* would go in *Natural Philoſophy*, has now manifeſted to the World to what ſurprizing Heights, even vulgar *Experiments* duly managed and carefully examined in ſuch Hands may advance it. In the general, I think we may ſafely conclude from Sir *Iſaac Newton*'s Diſcoveries. 1. That the *Sun* and *fixt Stars* are but *Planets* or *Earths* vehemently heated; or having their ſmalleſt Parts put in a ſtrong *vibrating* Motion. 2. That Light is emitted from them, by theſe powerful *Vibrations* of their ſmalleſt Parts. 3. That this Fluid of Light emitted from theſe *vibrating* luminous Bodies, requires a certain time in paſſing from them to us, and moves after the ſame manner other Fluids do, only with a much grea-

ter Velocity. 4. That Bodies draw this Light to 'em in Lines *perpendicular* to their Surfaces, and that this Light puts the parts of these Bodies in a *vibrating* Motion wherein Heats consist. 5. That the Motion of Light is swifter in Bodies than *in vacuo*, by reason of this Attraction; and slower after its being *reflected*, than in its *Incidence*, because that Force of Attraction which accelerates its Motion in its *Incidence*, must of necessity retard its Motion in its *Reflexion*, by reason of the different Direction thereof. 6. That the Ray in its whole Course of *Reflexion* and *Incidence* describes a *Curve*, or is rather bended than broken. 7. That the *Vibration* of the smaller parts of Bodies produc'd by the Action of Light, when brought to a certain Degree of Strength, is the Cause of their Light; just as we see the *Vibrations* produc'd in the Air by tremulous and sonorous Bodies, must be of such a determin'd Force to produce a distinct Sound. 8. That these *Vibrations* produc'd in Bodies by the Action of Light, when their Motion conspires with that of the Rays of Light, *i. e.* when any Ray is in that part of these *Vibrations* that has the same Direction with that of the Ray, it easily breaks through a *refracting* Substance, but when it is in the contrary part of the *Vibration*, which impedes its Motion, it is easily reflected, and so every Ray is dispos'd *alternately* to be easily *reflected* or easily *transmitted*. 9. That the

Rays

Rays of Light are of their own Nature diverſly *Refrangible* and *Reflexible*, and that this diverſity in both ariſes from the ſame Principle, acting differently in different Circumſtances, *viz.* the Action of Bodies upon Light. 10. That *Reflexion* is caus'd by the different Denſities of Bodies, and happens only in *Superficies* that intercede *Mediums* of different Denſities. 11. That Light is totally tranſmitted through *Mediums* only that are of the ſame uniform Denſity, and that the *refractive* Power of Bodies is principally owing to the Sulphurs with which they abound; for ſince all Action is mutual, and ſince Light congregated by a Burning-Glaſs acts moſt upon Sulphurs, ſo Sulphurs ought to act moſt upon Light. 12. That the Forces of Bodies to *reflect* or *refract* Light are very nearly proportional to the Denſities of the ſame Bodies. 13. That certain Colours are ty'd to ſuch Degrees of *Refrangibility* or *Reflexibility*, and that all the *primitive* and *original* Colours depend upon theſe Degrees. 14. That *White* conſiſts in an equal mixture of all the *primitive* Colours, and *Black* in a Suffocation of all the Rays of Light, which is the reaſon why *Blacks* burn more eaſily than other Colours; and other not *primitive* Colours ariſe from a certain mixture of theſe. 15. That the Colours of Natural Bodies depend upon the different Denſity of their ſmall Parts, and thereby their fitneſs to reflect Light of one

Colour and transmit that of others. 16. That several sorts of Rays make *Vibrations* of several bignesses, which according to their bignesses excite Sensations of several Colours much after the same manner, that the *Vibrations* of the Air according to their several bignesses excite Sensations of several Sounds. 17. That the *Harmony* and *Discord* of Colours arise from the Proportions of the *Vibration* propagated thro' the Fibres of the Optick Nerves into the Brain, as the *Harmony* and *Discord* of Sounds arises from the Proportions of the *Vibrations* of the Air.

## *Corollary.*

From what has been said of the Nature of the *Sun*, and its *Light*, it is evident, that the Quantity of Heat and Light in the *Sun* doth daily decrease; like other vehemently hot Bodies it must gradually cool; as also, by its *Emission* of so many Millions of Rays perpetually, quite round its Body, upon all the *Planets* within its System, which do not return, both its Bulk and Heat must be diminished. It is not improbable that all the virtual Heat in the Juices of Vegetables, Metals and Minerals, may be owing to the Action of the imprisoned Rays in 'em: the Production of Animals in the ordinary way, requires a certain Degree of Warmth, which proceeds from the *Sun*'s Influence. Some Bodies do stifle and suffo-

ſuffocate the Rays of Light, ſo as that they are never, or not duly reflected again. Sulphurous and Bituminous Bodies form little Cells by the Action of the Rays of Heat and Light, to retain 'em. All Bodies burn and emit Flames in proportion to the quantity of *Sulphurs* in 'em. Spirits by frequent Diſtillations may be drawn out of *Vegetable* Juices which ſhall flame and fume away of themſelves in the open Air. Nay, the *Sulphurous* parts of ſome Bodies may be ſo ſeparated from their Salin and Earthy parts, and ſo united, as to continue their Flames and Burnings even when cover'd over with Water; as the liquid and ſolid *Phoſphorus*, which only ſhow their Flames more conſpicuouſly when expos'd to the Air: all which ſhow how readily Light and Fire of all kinds, *Solar* and *Terreſtrial*, are receiv'd by *Sulphurs*, and how cloſely they are united with them; ſo that the Rays of the *Sun* are certainly ſwallow'd up by *Sulphurous* Bodies, and cannot be returned to their Fountain-head. Some have thought, that the Rays and Light of the *Sun* were diſſeminated through the whole Body of the *Atmoſphere*, even when their Fountain was got quite below our *Horizon*, by obſerving, that *Mercury* ſhut up in a *Tube* exhauſted of Air, if the *Mercury* had been firſt well cleans'd, the *Tube* perfectly exhauſted and cloſely ſeal'd up, but not quite fill'd with the *Mercury*, upon ſhaking briskly and frequently the *Tube* under theſe Circumſtances, in a darken'd Room, copious

Gleams

Gleams of Light would thereby be emitted, so as to enlighten the whole Room. But Mr. *Hauksbee* has made it evident, that any Friction with the Hand, or other soft Body, on an exhausted Glass, *Sphere* or *Cylinder*, when violently agitated or turned round very quickly, even without the *Mercury*, will produce the same Appearance; whereby it is evident, that it is the *Friction* which produces the Effect in both Cases; the *Mercury* in the Agitations of the *Tube*, rasping the Sides thereof, and setting its Parts in proper *Vibrations*, and the Hand or other soft Body, closely apply'd to the whirling exhausted hollow *Sphere*, or Glass *Cylinder*, producing the same effect; the drawing out the Air in both Cases contributing nothing to the Effect, but as the removing an Impediment to the due *Vibration* of the parts of the Glass; as we see the Application of any Foreign Body close to a Sonorous Body, will hinder those *Vibrations* which are the Cause of its proper Sound; and it is the proper, quick and strong *Vibration* of their Parts, that is the Cause of Light in Glass Bodies, and all others susceptible of it. But since it's certain, that Bodies do attract the Rays of *Light*, and do retain 'em so, that they can never return to the Fountain of *Light* again; it's plain, the Quantity of *Light*, both in this *Bright Luminary*, and in the *Sun-like fix'd Stars* must be continually decreasing. There is no Reason can be assigned

ed for doubting, that the *fix'd Stars* are of the ſame preciſe Nature with our *Sun*, and there are ſeveral probable Reaſons can be aſſign'd to ſhow their Similarity; the Light in both is of the ſame Nature, and all the ſeveral *Syſtems* tranſmit their Light into one another: Now it is Fact, that ſeveral *fix'd Stars* have diſappeared for many Years, ſome having again appeared, others never, as is evident from the Obſervations of *Aſtronomers*. And it's not unlikely that theſe diſappearing *fix'd Stars* were actually extinguiſh'd, that their Heat and Light were actually ſpent and exhauſted, and they turned into mere opake and groſs *Planet-like* Bodies, and would for ever continue ſo, if not re-kindled, and new recruited with Heat and Light; the Poſſibility of which, in ſome of the extinct *fix'd Stars*, may be afterwards accounted for. And if this be not very far from the Truth, we have here an undeniable Proof of the Poſſibility of the Decreaſe of Heat and Light in the *Sun*. However, it's alſo certain, that this Decreaſe is very inconſiderable in any ſhort time; tho' we are ſure there is ſome, and our not being ſenſible of this Decreaſe, is only an Argument of the exceeding Smalneſs of the Particles of *Light*. We find ſome *odoriferous* Bodies ſend out Steams for many Years, without ſenſibly diminiſhing either in their Bulk or Weight, which argues the Smalneſs of the Parts of theſe Steams. But the Particles of *Light* muſt

must be extremely small, since the *Sun* for so many Ages has been constantly emitting *Oceans* of Rays, without any sensible Diminution: But this can surprize no Body who considers that Matter is infinitely divisible; for it is possible to assign in Numbers, a Quantity, whereof a Body as big as the *Sun* may constantly, for any finite Number of Years emit *Oceans*, and yet the Sum of 'em all may not be greater than a cubical Inch, or even a Grain of Sand.

§ XLI. We have already observ'd, that the most general Condition of the *Universal Law* of Gravitation in Bodies, was, that at the same Distance from the Center of the attracting Force, Bodies did gravitate in proportion to their Solidity, and at different Distances, *reciprocally* as the Squares of those Distances; but this Condition may not be so general, as altogether to exclude others: The way to know how this *Universal Law* is diversify'd, in the different Bodies, is to observe what Lines Bodies in their Motions or Actions upon one another describe, or what the Effects of these Motions and Actions are; and then to investigate what Conditions of the *Universal Law* of Gravitation will make Bodies describe these Lines, or produce these Effects. Thus if any of the *Primary* or *Secondary Planets* did describe perfect Circles or *Ellipses* about the *Sun*, or a *Primary Planet* plac'd in the Center, the Condition of the *Universal Law* in these would be, that

that the *attractive Force* at different Distances from the Center, would be as these Distances directly. If they described a *Parabola*, by supposing the *attractive Force* at an infinite Distance, or an *Hyperbola*, by changing the *Centripetal* into a *Centrifugal Force*; then the Condition of the *Universal Law* would be, that the Force were always *equable* and the same at all Distances in the first Case, and as the Distances *directly* in the second, as Sir *Isaac Newton* has demonstrated, *Prop.* 11. *Lib.* I. We find, as has been insinuated in the preceding Sections, That the Rays of *Light* in passing thro' different *Media*, are attracted *perpendicularly*, to either the Plane of *Incidence* or *Reflexion*; so that the Force of Attraction is always the same, at equal Distances from the same Plane. We see that the Parts of *Air* shun or fly from one another, instead of tending to one another; so that in accounting for the Appearances of Nature from the *Universal Law* of Gravitation, we are not ty'd to one single Condition, but may have recourse to others, as the Nature and Necessity of the Appearances seem to require; for the whole Difficulty of *Philosophy* seems to lie in investigating the Powers and Forces of Nature, from the Appearances of the Motions given, and then from these Powers to account for all the rest.

§ XLII. The obvious Appearances of *cohering* Bodies are thus: Two very smooth, well-polished

polished plain Bodies, put together, will firmly cohere, even in an exhausted Receiver; which shows evidently that their *Cohesion* is owing, neither to the Gravity, nor to any other Property of the Air; Saline Particles, when at a proper distance, and at freedom, will shoot and unite into Clusters of themselves: All saline, crystalline, and most mineral Bodies, break in very smooth and plain, or at least *congruent* Surfaces; and universally almost all hard and very compact Bodies, break with Surfaces, which immediately upon the Separation, appear whitish, which is an Evidence, that tho' the Surfaces be very small, yet they are very smooth and polish'd, for only innumerable little polish'd Surfaces are fit to reflect plentifully all kinds of Rays, whereby white Colours are produc'd. Now these Appearances of *cohering* Bodies, do naturally lead us to imagine, that one necessary Condition toward *Cohesion*, is the plainness, or at least *Congruity* of *cohering* Surfaces, and this seems necessary to exclude any Fluid from lying between *cohering* Bodies; for these Bodies cannot be said to *cohere*, or be continued, betwixt whose *cohering* Surfaces, in all their Points a Fluid may insinuate it self. The plainness and smoothness of the *cohering* Surfaces, will make more Points come into *Contact*, than when they are rough and irregular. For whatever Cause *Cohesion* arises from, if we suppose that Cause

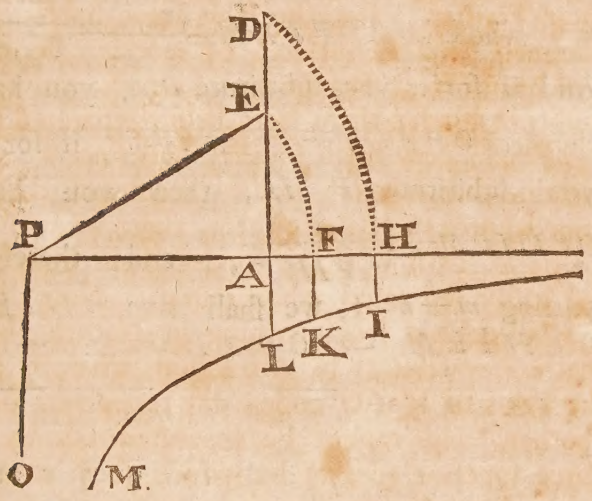
to

to act most strongly at the *Contact*, the more Points of the *cohering* Bodies come into *Contact*, the firmer the *Cohesion* will be; and tho' exact Congruity in *Curve* Surfaces, will bring as many Points into *Contact* as plain Surfaces will, yet *Curvity* not being the simplest, nor most expeditious Method of producing this Effect, neither agreeable to Nature (who always brings about all her Effects the shortest and easiest way) it seems evident, that the plainness and smoothness of Surfaces, is one Condition of *Cohesion*, and that those *Atoms* that are terminated with plain Surfaces, will (*cæteris paribus*) produce Bodies of the firmest *Cohesion*. This will appear more evident from the contrary Quality in the constituent Particles of Fluids: For we have shown before, that one necessary Condition of *Fluidity*, is the *Curvity* of the Surfaces of the constituent Particles of Fluids, whereby their *Cohesion* is very small, in respect of the *Cohesion* of those Particles that are terminated with plain Surfaces, and their Gravity always exceeds the Force of their *Cohesion*, so that from both these Causes, they easily slip and move one upon another. We may then suppose, that some of the *Primary Atoms* of which Bodies are constituted, are terminated with plain Surfaces on all sides, which will produce Bodies of the firmest *Cohesion*; others are partly terminated with plain, and partly with *curve* Surfaces, which will pro-

produce Bodies of a mean *Cohesion*; others again are intirely terminated with *curve* Surfaces, which will produce Fluids, and between those intirely plain, and intirely *curve*, there are infinite *Combinations* of plain and *curve* Surfaces, which will account for all the various Degrees of *Cohesion* in Bodies, in respect of their Figures. But tho' this smoothness and plainness in the Surfaces of *cohering* Bodies, will bring most Points into *Contact*, yet this will not hinder them from being separated by any Force, how small soever; and since we are certain, that *cohering* Bodies require a determined Force to separate them, there wants still a *Cement*, as it were, to hinder them from being easily separated when join'd. Now this can be deriv'd from nothing in Nature, but that *Universal Law* of Attraction, whereby all the Parts of Matter endeavour to *embrace* one another, and cannot be separated but by a Force superior to that by which they attract one another; let us then enquire what Condition of the *Universal Law* will most fitly answer the Appearances of *Cohesion*.

§ XLIII. On the Center *A*, and at the Distance *A D*, let a Circle be describ'd, to whose Plane at *A*, let *P A* be *perpendicular*, and *P* be a *Particle* of Matter, attracted by all the Particles of this Circle, in any Condition of the *Universal Law*, from *P*, to any Point in the

the *Radius* of the Circle draw *P E*, in the right Line *P A*, take *P F* = *P E*, and at *F* draw *F K* parallel to *A D*, of such a length as may represent the Force whereby the Particle *E* at-




tracts the Body *P*, and let *L K I* be the *Curve* which the Point *K* thus constantly circumstantiated Generates: Sir *Isaac Newton* has demonstrated, *Pag.* 196. *Prop.* 90. *Lib.* I. *Princip. Phil. Mathemat.* 2*d Edit.* that the Force whereby the whole Circle, upon the *Radius A D*, at-

tracts the Corpuscle $P$, is as the $AHIL$ multiplied upon the Distance $AP$, let $PF$ be called $x$, and $FK$, $y$; and let $FK$, or the Force whereby the Point $E$ attracts the Body $P$, be reciprocally as any Power (suppose $n$) of $PF$, then the *Equation* of the *Curve* will be $y = \frac{1}{x^n} = x^{-n}$ whose *Area* $OPFKM = \frac{x^{1-n}}{1-n} = \frac{1}{1-n}x^{n-1}$ And if for $x$ you substitute $PA$, you have the *Area* $OPALM = \frac{1}{1-n}\overline{PA}|^{n-1}$. If for $x$ you substitute $PH$, then you have $OPHILM = \frac{1}{1-n}\overline{PH}|^{n-1}$, and therefore putting $m = n-1$, we shall have $AHIL = OPHILM - OPALM = -\frac{1}{m} \times \overline{PH}|^{n-1} \frac{1}{m} \times -\overline{PA}|^{n-1} = \frac{1}{m \times \overline{PA}|^{n-1}} - \frac{1}{m \times \overline{PH}|^{n-1}}$, and consequently the *Attraction* of the Circle upon the *Corpuscle* $= PA \times AHIL = \frac{PA}{m \times \overline{PA}|^{n-1}} - \frac{PA}{m \times \overline{PA}|^{n-1}} = \frac{1}{m \times \overline{PA}|^{n-2}} - \frac{PA}{m \times \overline{PH}|^{n-1}}$.

If

If $n = 1$. and $PA = 0$, then the *Radius* of the attracting Circle being produc'd, will coincide with the *Asymptote PO*, in which Case (the *Curve* being the vulgar *Hyperbola*,) the *Area AHIL* will be infinite, and *PA* being nothing, or the Distance between the *Corpuscle* and the *attracting Plane* vanishing, the *Attraction* $PA \times AHIL = 0 \times \infty = 1$.

If $n = 1$ and $PA = \infty$ *i.e.* when the *attracting Plane AD*, is plac'd at the *Concourse* of the *Hyperbola*, with its *Asymptote PH*, then the Arch *DH* (whose Center is *P*, and whose *Radius* is $PD = PA = \infty$.) will coincide with *AD*, and consequently *AL* and *HI* will coincide, and therefore $PA \times AHIL = \infty \times 0 = 1$.

If $n = 1$ and $PA = a$, let *AH* be called $y$, then $PH = x = a + y$. And the *Attraction* of the Circle upon the *Corpuscle* $PA \times AHIL = y - \frac{y^2}{2a} + \frac{y^3}{3a^2} - \frac{y^4}{4a^3}$ &c.

If $n = 2$. and $PA = 0$, then the *Area AHIL* will be *more than Infinite* (the meaning of which Expression shall be afterwards explain'd) and therefore the Attraction will be $PA \times AHIL = 0$ multiply'd into more than Infinite; from whence it appears that the Force of the *Attraction* in this Case, when $PA = 0$, is greater than that in the former Case, where $n = 1$. and $PA = 0$.

If $n = 2$ and $PA = \infty$, there the *Area* $AHIL$ will be nothing, and consequently the *Attraction* $= PA \times AHIL = \infty \times = 1$. And hence it appears that in this Case, if $PA = o$, the *Attraction* will be greater than when $PA = \infty$. for of two Products, having the same Multiplicator, that is the greater, which has the greater Multiplicand, so that if $A$ denote the *Attraction*, when $PA = o$ and $a$ the *Attraction*, when $PA = \infty$, I say that $A$ is to $a$, as a greater than infinite is to infinite, contrary to what happen'd in the first Case, where $n = 1$, for the *Attraction* in that Case was the same both when $PA$ was equal to $o$ and to $\infty$, *viz.* 1.

If $n = 2$ and $PA = a$, then as formerly $AH$ being call'd $y$, the *Attraction* $= PA \times AHIL = \frac{y}{a} - \frac{y^2}{a^2} + \frac{y^3}{a^3} - \frac{y^4}{a^4} + \frac{y^5}{a^5}$, *&c.*

If $m = 3$ and $PA = o$, then $AHIL$ will be more than infinite, but $AHIL$ in this third Case will be greater than $AHIL$ in the second Case, and consequently the Force of the *Attraction* when $PA = o$ in both Cases, will be greater in this Case than in the second Case, for the reason now mentioned, *viz.* because $PA = o$ is a common Multiplicator in both, and AHIL in this Case is greater than AHIL in the second.

If $m = 3$ and $PA = \infty$, then as before, AHIL will be equal to nothing, and consequently the *Attraction* will be $\infty \times o = 1$.

If

If $m = 3$ and P A $= a$, then the *Attraction* will be equal to $\frac{y}{aa} - \frac{3y^2}{2a^3} + \frac{2y^3}{a^4} - \frac{5y^4}{2a^5} + \frac{3y^5}{a^6} - \frac{21y^6}{6a^7}$, *&c.* After this manner, the Force of the *Attraction* of the *circular Plane* upon the *Corpuſcle* P, may be eaſily computed in an aſſignable caſe of the *Powers* of the Diſtance P E, and at any aſſignable Diſtance of the *Corpuſcle* from the Plane.

From theſe *Calculations* it is evident, that the Force of the *Attraction* of the Plane upon the *Corpuſcle*, when the Diſtance is nothing, or when the Plane and the *Corpuſcle* come into *Contact*, increaſes when the *Powers* of the Diſtance $n$ increaſe; thus when $n = 2$. and P A $= o$, the Force of the *Attraction* is greater, than when $n = 1$ and P A $= o$, and ſo in others higher. As alſo it's clear from theſe *Calculations*, that the Force of the *Attraction* of the Plane upon the *Corpuſcle*, at the ſame finite Diſtances decreaſes faſter, or at a greater rate, when the *Powers* of the Diſtances are high, than when they are lower, or when $n$ is a greater Number, than when it is leſs; thus at the ſame finite Diſtances, the Force of the *Attraction* is much leſs *proportionally*, when $n = 3$, than when $n = 1$, or 2, and ſo in others where the Difference between $n$ in one Caſe and in the other, is yet greater.



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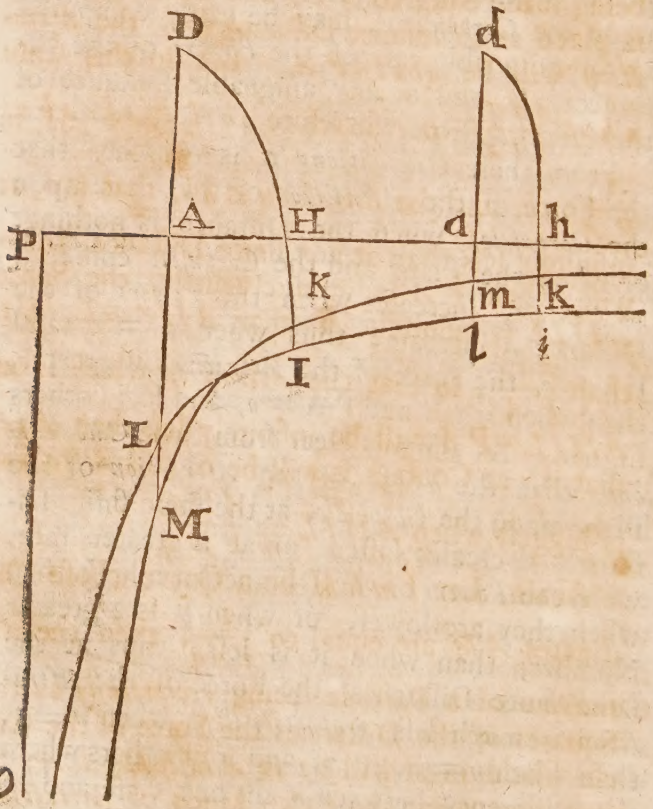
Lastly, Suppose the attracted Particle *P* and *P A H a h* and *P O* to be the *Asymptotes* of the *Hyperbola*, whose Ordinates are proportional to the *Attraction* of a Particle at their respective




Distances from *P*, then if the *Attraction* be reciprocally as the Distances, having described the common *Hyperbola* *i l I L*, whose Ordinates

nates $AL$ are equal to $\frac{1}{PA}$ the *Attraction* of a Circle whose Radius is $AD$, will be as the *Hyperbolical* Space $AHIL \times PA$, the Line $PH$ being made equal to $PD$, and when the Circle is plac'd at an Infinite Distance $Pa$, the *Attraction* will be $ahil \times PA$. But in this Case $ah = \frac{adq}{2Pa} = 0$, wherefore $ahil = al \times ah = \frac{1}{PA} \times ah$, and the *Attraction* is $ah$, that is 0, or infinitely less than at any finite Distance. Likewise when $PA$ is infinitely little, the Space $AHIL$ is infinitely less than $AH \times AL$, *i. e.* than $\frac{AH}{PA}$; so that the *Attraction* which is as $AHIL \times PA$ will be infinitely less than $AH$, that is, at Contact it will be 0, this *Attraction* is biggest when $AHIL = \frac{ADq}{PDq}$.

Again, Let $kmKM$ be a Curve whose Ordinates $AM$ are equal to $\frac{1}{PAq}$, then the *Attraction* of a Particle being *reciprocally* as the Squares of the Distances the Force of the Circle plac'd in $A$ will be as $AHKM \times PA$: So that comparing these two kinds of *Attractions* together, the *Radius* of the Circle $AD$ being given, and the Distance $PA$ the same in both Cases, they will be as the Spaces $AHIL$ and

*AHKM*, which when the Distance is infinite is, as the Ordinates *hi* and *hk*, *i. e.* as $\frac{1}{Pa}$ and $\frac{1}{Paq}$, or as *Pa* to 1, that is, as infinite to finite. And when the Distance as 0, it is as 0 to 1. In the same manner, if the *Attraction* be reciprocally as the *Cubes* of the Distances, at the Contact the Force will be infinitely greater, than when the *Attraction* decreases as the *Squares*. If it decreases in a *Quadruplicat* proportion of the Distances, the Force at Contact will be infinitely greater, than when it decreases as the *Cubes*, and so on. So that if *n* be taken successively, as 1, 2, 3, 4, *&c.* the corresponding Forces at Contact will be as $0. 1. \infty . \infty^2$, *&c.* And if we should compare the same Forces at an infinite Distance, they would be $0. 0^2. 0^3. 0^4$. *&c.*

Now to apply this to the *Cohesion* of Bodies: It's certain that the first Condition (*viz.* when the *Attraction* is reciprocally as the Distance between the *attracting* Bodies) cannot obtain in the *Cohesion* of Bodies; for the Difference between the Force, when the Bodies are in *Contact*, and when they are at some Distance from one another, in this case is so small, as does not answer the *Appearances*: for we find, that the Force whereby Bodies *cohere*, is very much greater, when they come to immediate

Con-

*Contact*, than when they are at ever ſo ſmall a finite Diſtance from one another.

In the ſecond Condition of the *Univerſal Law* of *Gravitation*, (*viz.* when the Force is *reciprocally* as the *Squares* of the Diſtance,) the Difference of the Force of *Coheſion*, between Bodies at immediate *Contact*, and of the ſame, at ſome Diſtance from one another, is greater than in the former Caſe; but not ſufficient to account for this Difference obſervable in the manner of the *Coheſion* of Bodies. But if it were poſſible to gather by *Experiment*, the *proportion* of the decreaſe of this Force, in *cohering* Bodies, to the ſame, at ſome determin'd Diſtances from one another, that would give the Condition of the *Univerſal Law*. But it will be very difficult to make any ſuch *Experiments*, becauſe the Fluids which ſurround Bodies, upon the Surface of our *Globe*, get in between the Surfaces of Bodies when they are at any Diſtance, greater than the *Diameters* of the conſtituent Particles of theſe Fluids, and ſo by their lateral preſſures, deſtroy the efficacy of the Force whereby Bodies *cohere*; thus the Particles of *Light*, and of *Air*, get in between the Surfaces of Bodies, remov'd at almoſt an inſenſible Diſtance from one another, and ſeeing *Light* and Bodies act mutually upon one another, and that the Particles of *Air*, endeavour to recede from one another, they render the efficacy of the Force of *Attraction* whereby

whereby Bodies *cohere*, altogether insensible at any Distances from one another, greater than are the *Diameters* of the Particles of these Fluids; and a Distance equal to the *Diameters* of such subtil Fluids, is too small to be distinguish'd by our Senses, howsoever assisted. After all, it seems pretty difficult, to conceive all the Varieties of *Cohesion* in Bodies, from that one Principle of *Attraction*, and the plainness of Congruity of Surfaces. For there is no one Law of *Gravitation* comprehended in $\frac{1}{x^n}$ $(=y)$ which will beget a Curve $IKLM$, that will answer both these Conditions, $o \times AHIL =$ to something, and $PA \times AHIL =$ to nothing; which it seems it must do to explain *Cohesion*. Besides, it would agree much better with the simplicity of Nature, if the general Law where $n = 2$, which obtains in the Celestial Bodies, cou'd be made agree with the Appearances of *Cohesion*. It is not impossible, that the Attraction, which at contact in this last mentioned Case, is 1 or finite, at any Distance whatsoever that Human Experiments can determine or observe, may be so intirely destroyed by the Interposition of foreign Fluids (that are not subjected to any of our Experiments in exhausting, such as is Light, and perhaps a yet more subtile Fluid. *Vid. pag. ultim. 2d Edit. Princip. Newtoni)* acting in a contrary Direction, as to leave no remaining Force in it: Or perhaps

perhaps the Figures of the conſtituent Particles of Bodies are to be conſidered in the Affair of *Coheſion*, as well as the Law of *Attraction*, to give a ſatisfying Account of it.

§ XLIV. *Coheſion* in general, being ſuppos'd after ſome ſuch manner as has been explain'd, it is no hard matter to underſtand *Elaſticity*, which ſeems to ariſe from the ſame *Principles*, of ſmooth and plain Surfaces, and of ſome one or more of the mention'd Conditions of the *General Law of Attraction*. In bending *elaſtick* Bodies, we find the *Convex* ſide exceedingly ſtretch'd, inſomuch, that by frequent and long continued Bendings, there become viſible *Fiſſures* in the out-ſide, which no doubt were there before, or in the firſt Bendings, tho' not ſo large, as to be viſible, as alſo we ſee the *Concave* ſide, mightily contracted, or its Parts forcibly preſs'd together, ſo as to run into Folds or leſſer *Convexities*, on the in-ſide: the ſame thing happens, when two *elaſtick* Globes or Balls, ſtrike againſt one another, only the *Convex* ſides, are turn'd in towards their *Centers*; the Matter being thus, let us ſuppoſe, that two very ſmooth and plain ſquare Surfaces, are join'd together, ſo that each Particle in theſe Planes, attracts another, by ſome one or other of the Conditions of the *General Law of Attraction*; if theſe Planes, by any external Force, were ſo ſeparated, as to move upon a common ſide of the Congruent ſquares as an *Axis*, and

that

that no foreign Fluid endow'd with a disjoyning Force (such as *Air* and *Light* are) cou'd interpose to hinder their Action: it is certain, that the external Force which thus separated these Planes, ceasing to act, the *Attractive* Force wou'd immediately bring these Planes together again; and if these Planes were separated by a *parallel* Motion, if the Distance were so small, that no foreign Fluid could get in to hinder their Action, if the *separating* Force ceas'd, the *attracting* Force would act and bring 'em together again; and in both Cases, with a Force which may be easily gathered from the Condition of the Law of *Attraction*, and the Distance of these Planes being given. Now all *Elastick* Bodies in their Actions upon one another, changing their Figures, must of necessity have some of their Parts in these Actions, separated by a *Parallel* or a circular Motion about an *Axis*; or by a Motion after some manner compounded of both these, (for it is no matter after what manner they are disjoin'd, provided they be not separated so far, as to admit any foreign Fluid to enter, which may destroy the efficacy of the Force, whereby these Particles *attract* one another) If we then suppose the Surfaces of the Parts of *Elastick* Bodies, plain and smooth, and that they *attract* one another after some one or other Condition of the *Universal Law*; being separated by a foreign Force, they must (when that Force ceases)

ſes) join together again with a certain degree of Force (which is to be eſtimated from the Diſtance and Condition of the *Univerſal Law* being given) and ſo will produce all the *Appearances* of *Elaſtick* Bodies.

It may be objected, that it does not appear from this Account of *Elaſticity*, how a Spring ſhould grow ſtronger the more it is bent, ſince in that caſe, the *Fiſſures* being made wider, the attractive Force ought to be leſſen'd, and conſequently the Power of *Reſtitution* ought to be ſo too. All I can ſay to this is, that there is a proper arrangement of the Parts to be brought about in *Elaſtick* Bodies, which may in ſome meaſure be more readily obtain'd or facilitated by uſe; as we ſee Watches go more regularly, ſmoothly and exactly after they have been us'd for ſome time; and it is pretty certain, that *Elaſtick* Bodies, upon this account, may run more readily into their Actions, when the Parts by uſe are form'd and fix'd in the Situation moſt proper for this purpoſe, which at firſt they may not ſo perfectly be, by reaſon of the ſolidity and firmneſs of the Parts of moſt *Elaſtick* Bodies: To confirm this, we ſee Springs by too long uſage, when the Parts are too much worn out, and the Chaps and Fiſſures become too large and viſible, decay and loſe their Power of *Reſtitution*, like other Organical Bodies, which Time and too long uſe wear out and render uſeleſs for their intended purpoſes. But perhaps the Appearances of *Co-*

*heſion*

*hesion* may be more congruously accounted for, from a proper Conformation of Parts, and the Action of an *Elastick* Fluid, which owes its Nature to the *Centrifugal* Force of its Parts: But this I am not at leisure to explain in the Particulars. Upon such *Principles* may the *Elasticity* of *Tendinous* Bodies be explain'd, but it is not my Business here to descend into all the particular Circumstances. If *Elastick* Bodies observ'd one constant *Proportion* in their unbending, toward their bending Forces, it were easie from thence, to determin the Condition of the *Universal Law* by which their Particles attract one another; but perhaps some may think, there are as great Varieties in this as in *Cohesion*; I shall not therefore trouble the Reader, in this place, with the particular Consequences, from particular Conditions of the *General Law* of *Attraction*, but shall content my self to have laid down *Principles* upon which these intricate *Appearances* may be, in some probable manner, accounted for.

I would proceed to some of the rest of the *Appearances* of Nature, which might be accounted for from the same *Principles*, but that these already explain'd are most of what I shall make use of in the following Treatise, for which this *Chapter* was design'd only as a *Lemma:* Besides, that some of the rest will naturally come into the Subject of these other Discourses.

CHAP.

## CHAP. III.

### *Of the Origin of the present State of Things, and of the* Epicurean *and Mechanical Hypothesis.*

§ 1. IT is a little surprising to see Men frequently contending and wrangling about the *Origin* of their several Families, and yet scarce any Body give Himself the trouble once seriously to consider or enquire how the whole Race at first became to *be*, whether it sprang from the *Earth* or dropt from the *Clouds*, when it began, or if ever there was a time when it was not; tho' these Enquiries be far more worthy a wise Man's pains than those insignificant Contests. We are easily satisfy'd we and our immediate Parents have not been for ever; but few of us go farther, we take this World as we find it, without troubling our Heads *who made it*, or whether it was *made* or not. No Body can well bear to have their *Ancestors* affronted, nor their *Pedigree* despised; and yet very many now a days don't scruple to own themselves the *Children* of the *Earth*, or the Offspring of *blind Fate and Chance*. Whatever others may do, I shall not think my Pains ill bestow'd once in my Life to have examin'd

min'd, as far as my poor Abilities will carry Me, how this present state of things became at first to *be*.

§ II. There are three general Opinions about this matter, the first is of those of the *Epicurean* Sect, that holds that an *immense Void*, and an Infinity of differently figur'd, very small, extreamly hard and infrangible *Particles of Matter* have for *ever been*; and that these Particles moving of 'emselves in a direction oblique to one another, after innumerable *rencounters*, did at last settle in this *beautiful order of things* we now behold. This is a *Scheme* upon which some build their *Hopes*, and upon the account of which some of our *Moderns* think 'emselves subtil *Philosophers*, how justly we shall now examine.

§ III. First this *Scheme* supposes Matter to have for ever been of it self, without any Cause; which is a very liberal Compliment to such an unactive inanimate Mass, to make it independent for its Being and uncapable of being destroyed (both which *Self-existence* necessarily implies) *that is* to make it necessary, *that is* to make it infinite and eternal, and to raise it to a very high pitch of Dignity, to which we find none of its other qualities answerable. *Time and Space* or something *Analogous* to what we call by those names, it's true may have for ever been; but that is because they may have some relation to a Being endow'd with all other suitable qualities; but Matter seems to be too ignoble a Being to arro-

arrogate such high *Endowments*. But pass we over this Head at present, as not essential to the Business in Hand. And,

§ IV. Let us consider how out of these few *Principles* of an *immense Void*, an infinity of very small, hard and infrangible *Particles*, and their *oblique Direction* to one another, it is possible to form this present State of things. We have prov'd, § XI. of the preceding *Chapter*, that *Motion* is no more *essential* to Matter than Rest; that of it self it can never bring it self into Motion; that it would for ever continue in the State it is put in, and, if it was from all Eternity at Rest, it would continue so for ever; if in Motion, it would for ever move on. Now this being the Case, it would have been a great advantage to their Opinion, could they have shown whence this Motion did at first proceed; since it is suppos'd there is nothing beside unactive Matter it self to produce it. Whatever can be suppos'd to put Matter in Motion, may at the same time, and with the same ease, be suppos'd to have directed the several Parts thereof to the Places they are now in, *i. e.* to have produc'd this *present State of things*. No Body can think Motion *essential* to Matter, who sees any Part thereof at rest; for what is *essential* to any thing, that thing can never be without it. But some *Philosophers*, and those of great Name too, have asserted, that no part of Matter ever was nor can be

at absolute rest. For, say they, Motion is a Quantity, and may be divided *in infinitum* as well as other Quantities, and a Body may be moving any finite time, and yet never sensibly change its *relative* Place; for the Space is as the Velocity, and if the Velocity be very small, the Space it moves through is so likewise: And they alledge, that those Bodies which seem to be at rest, are only alternately moving very slowly to and from the *termination* of the Motion, or the *Obstacle*. To this I answer, that tho' it may be very true, that nothing in this Universe is actually at *absolute rest*, but that every thing is in some degree of Motion; yet that absolute Rest in Bodies is not impossible, is clear from hence, that it implies no Contradiction: A Sphere in a Vacuity should be press'd by two other equall Spheres, with equal Forces and contrary Directions, from which pressure the intermediate Sphere would be at *absolute rest*; wherefore, if it is not absurd a Body should be at *absolute rest*, it is impossible Motion should be *essential* to Matter. There is another Argument, which to me seems very conclusive against Motion's being *essential* to Matter, and that is, from the infinite possible Varieties of its Directions; laying aside the consideration of all other Bodies, or supposing a Body moving *in vacuo*, it must move in one certain *Direction*. Now what is it that determines it to this *Direction* rather than

than to any other of the infinite Variety; no Reaſon can poſſibly be aſſign'd, why it ſhould move rather in this than in any other of the infinite number of Directions. And it cannot poſſibly move in more than one of 'em at once, and therefore it will of it ſelf move in none of 'em, *i. e.* it will not of it ſelf move at all, and conſequently, Motion is not *eſſential* to Matter. For in the Faculties of natural things, which are not endow'd with Free-will, where there is an infinite variety of Choice, and no poſſible Reaſon to determin any one way, there can be no Choice made at all. From all which it is plain, that allowing the *Abettors* of this *Philoſophy* their *Void* and their *Atoms*, yet nothing cou'd be produc'd for want of Motion, it not being *eſſential* to Matter, as has been prov'd, and there being nothing elſe to produce it.

§ V. But allowing Matter to be *ſelf-exiſtent* and *ſelf-moving*, I would know whence came this *obliquity* of *Direction*, which they *gratuitouſly tack* to Matter; this is to aſcribe Will and Choice to theſe Particles, and to alledge, that they are capable of reſolving what way they will go. The Contrivers of this *Scheme* ſaw wiſely enough, that granting theſe *Atoms* to be *ſelf-moving*, yet nothing would follow but an eternal wandering in Lines *parallel* to one another, without any other effect; and therefore they added, that theſe Particles mov'd with

different *oblique Directions* to one another, by which means they would meet, and justle, and reflect, innumerable different ways. But does not every Body see, that it is as easie and as intelligible to suppose this World already in Being, as to suppose these Particles endow'd with this *obliquely* directed Motion, the Cause of the one being no less accountable from their Principles than the other. We see all Motions now perform'd in the same Direction with that of the moving Force, and all Motions produced by the same *adequate Cause* have the same *Directions*; and consequently, if the Motion of these Atoms arises from themselves, they must all follow the same *Directions*, *i.e.* they must all move in *parallel* Lines; and consequently, they could never meet in order to produce any regular Effect. It is surprizing we should not find that Matter or Bodies now can alter their Directions, and yet, according to the Opinion of these Men infinite Ages by-past, they have mov'd as they listed. Why do they not so still? Since (according to their own Supposition) nothing has happen'd to alter their Nature, or the manner of their Motions ever since; it is altogether unaccountable why Matter should move in one *Direction* rather than another, upon any other account but the *Direction* of the impress'd Force; and all that's alledg'd on this Head by the *Favourers* of this *Scheme* is altogether *precarious* and *absurd*.

§ VI. But

§ VI. But allowing these *Atoms* to be *self-existent*, *self-moving*, and *obliquely* directed, yet 'tis still inconceivable how they should produce a World. For these *Atoms* could not move all with the same degree of Obliquity to one another, for that would be making 'em all *converge* to a Point, and so nothing but one great solid Sphere could be produc'd, if they happen'd to unite after their meeting: And if they again reflected from one another, they would produce a fluid Sphere, their rectilinear Motions turning into circular ones, or otherwise would wander on in right Lines as before. And to make some converge to one Point, others to another, is to say, these Atoms were intelligent free Beings, which could chuse the Course they would go in. We have a very powerful Proof of the insufficiency of these *Atoms*, tho' endow'd with their *obliquity* of *Direction* to produce any thing, in the Rays of the Sun; which, as was before prov'd, are very small Parts of Matter, by the interposition of the Surfaces of reflecting Bodies differently situated, obtaining all possible varieties of Obliquity; and yet these produce no regular *Systems* of Bodies, tho' they move and probably justle and interfere all imaginable ways. As I have just now said, those only whose *Directions* converge to a Point, could meet to produce any real Body, and even the Body which would be produc'd would only be a *spher-*

*rical* one. So that out of all their Motions, only *Spheres* of different Magnitudes could be form'd, which how small a part this is of the infinite variety of Bodies in this Universe, I leave the Reader to consider. The Truth of the matter is, if Bodies were *self-moving*, they could move what way they pleas'd, and stop when and where they pleas'd, *i. e.* they would be free-will'd *Elective* Agents.

§ VII. Again, allowing these *Atoms* to be *self-existent*, *self-moving*, and *obliquely* directed, yet I would gladly know, how from thence this *Universe* could be fram'd. It is not enough to say barely these *Atoms*, thus dispos'd, would at last settle into this State of things, unless it be shewn by what particular *Motions*, *Directions* and *Reflections*, the principal Bodies of this Universe were fram'd. To shew a thing possible to be done, we must tell how, what way, and by what Laws it may be done. For unless we descend to Particulars, we are never certain it can be so; and 'tis as probable (till the contrary be evinc'd, in some Particulars at least) it may not be so. *Generals* are always to be suspected; a Contradiction may be discovered in the particular Explications of an Appearance that was not taken notice of in the *general Scheme*; as indeed it happens in every individual Instance of this present Subject hitherto attempted. I shall not ask of those who defend this *Scheme*, a particular account of

of the *Mechaniſm* of every individual Appearance in our *Syſtem*, for that indeed were endleſs: But if any one can tell by what Laws of Mechaniſm, any one Animal or Vegetable was produc'd, or from what mechanick Principles the Planets deſcribe *Elliptick* Orbits, I ſhall for the ſake of theſe allow their whole *Scheme* to be true. We all know how wretchedly *Des Cartes* (the ableſt *Patron* that ever this Opinion had) has blunder'd on theſe Heads, and his Followers have not mended the matter much. It is ſurpriſing to think how any reaſonable Man could believe this *Univerſe* to have been produc'd by Matter and Motion, when as yet no Man that ever liv'd, from theſe Principles alone, can tell by what *Mechaniſm* the moſt contemptible of the *Celeſtial* or *Terreſtrial* Bodies could be produc'd; and yet to be fully ſatisfy'd of the Truth of this *Hypotheſis*, a Man muſt underſtand the particular Mechaniſm of the whole *Syſtem* of Things, and of every individual Appearance.

§ VII. Theſe *Atoms* are ſuppos'd *infrangible*, extremely compacted and hard (as indeed the leaſt Parts of Matter muſt neceſſarily be) which *compactedneſs* and *hardneſs* is a demonſtration, that nothing could be produc'd by 'em, ſince being ſo, they could never come to cohere, in order to produce ſolid Bodies. The only tolerable account of *Coheſion* in ſuch like Parti-

cles, is from their branch'd Figure. Now hard solid Particles reflecting from one another, can never possibly lay hold of one another, at least not so but that the least Motion will disjoin 'em again. It is impossible to conceive, how innumerable hard and compacted *Atoms*, swimming in an immense *Abyss*, could ever come to cohere, so as to produce such hard Bodies as *Diamonds*, and some other *Mineral Substances* are, without any other cement but their catching hold of one another; this mutual embracing might keep 'em from being easily torn asunder, but they would be still moveable like chain'd Work, and could never produce the appearance of Firmness and Solidity. And what is here said of Cohesion and Solidity, may be likewise shewn of Elasticity. And thus allowing these *Atoms* to be *self-existent*, *self-moving*, and *obliquely* directed, and to meet according to any Laws of *Mechanism*, yet they could only produce loose heaps of *Atoms*, or such moveable ones that are altogether unlike the solid Bodies we now behold. So that to account for the production of this present State of things, besides their Matter and Motion, the *Abettors* of this Opinion want a Principle for Solidity, or Cohesion and Elasticity; both which are owing to no essential Property of Matter, as is shown in the two last *Sections* of the preceding *Chapter*.

§ VIII.

§ VIII. There are ſeveral *Appearances* abſolutely unaccountable from the Laws of *Mechaniſm*, and conſequently, theſe could never be produc'd by Matter and Motion alone, or any *Combinations* of 'em. It were endleſs to alledge all the Inſtances that might be brought on this Head; ſome few of the moſt conſiderable will ſuffice; for if any one be inconſiſtent with the Laws of *Mechaniſm*, then it is impoſſible this *Syſtem* could have been produc'd by the concourſe of *Atoms*. The firſt I ſhall inſtance in, is that great Law to which all the Bodies of this Univerſe ſeem to be ſubject, *viz.* That of *Gravitation*. In the former *Chapter* I have endeavour'd to ſhew, that this Property is not *eſſential* to Matter, nor can ariſe from the Figure, Texture or Motions of its Parts, but is *implanted* therein by ſome Power ſuperior to that of Matter; whence it is evident, that one of the primary Attributes of Matter is independent of the Laws of *Mechaniſm*. That active Principle which animates, as it were, the dead Maſs of Bodies, and which is the Cauſe of all the beautiful *Appearances* of Nature, owes its Origin to ſomething different from Matter and Motion, and therefore this *Syſtem* of things could not ariſe from thence.

§ IX. Not only *Gravitation*, or that implanted Principle whereby Bodies tend towards one another, is above the Powers of Matter, but all the Effects and Appearances that neceſſarily

ceſſarily depend thereupon, *i. e.* all the *Celeſtial* and *Terreſtrial Appearances* are likewiſe above the Powers and Laws of Matter and Motion. All the Attempts of others before Sir *Iſaac Newton*, to explain the regular and conſtant *Appearances* of Nature were moſt of 'em *Ungeometrical*, and all of 'em ſo inconſiſtent and unintelligible, that it was as hard to allow their *Poſtulata*, as to conceive the thing which they pretended to account for from them. All the *Philoſophers* that ever were, could never from the meer Laws of *Mechaniſm*, explain how the Planets came to move in *Elliptick* Orbits, they might (if Matter had been ſelf-moving) have for ever ſtray'd in right Lines; but, that they ſhould conſtantly revolve in Orbits, that they ſhould approach to and remove from a determin'd Point at different Seaſons, and that uniformly and conſtantly, is altogether unaccountable from the Laws of *Mechaniſm*, as has been ſhewn in the former *Chapter*. But from this implanted Principle of *Gravitation* (ſuppoſing they are already put in their Motions, and that all the *Celeſtial Machinery* is now actually in motion and at work) all the *Phænomena* are accounted for, and that to the greateſt nicety we are capable of diſtinguiſhing. So that not only this Univerſe could not have been produc'd by the Laws of *Mechaniſm*, but there is ſcarce a ſingle *Appearance* that can thence adequately be accounted for.

I have already distinguished between the *Laws of Creation*, and that of *Nature*: The first are the Laws observ'd by the *Universal System of Things*, whilst it was in *Fieri* (as the Schools speak); the latter the Laws of the Actions of Bodies, when it (the System of Things) is in *Facto esse*. The first are quite different from the latter; for tho' Matter and Motion might help us to explain some small part of the Appearances, now Things are actually constituted; tho' even this be false, yet these, with all the Laws of Nature, and throwing in *Gravitation ex abundanti*, will never help us to explain one single Appearance of Creation, Original Production, or the Primitive Formation, Adjustment and Arrangement of the greater or smaller integral Parts of this *System of things*. Can any one tell from these Principles, how the Figures of the Bodies of *Sun*, *Planets* and *Satellits* were rounded into their particular *spheroidical Orbs*? How the Kinds and Positions of their *Orbits* were determin'd? Whence their Number, Magnitudes and Density came? They may continue their Motion in empty Spaces, and describe their determin'd *Orbits* by the Laws of *Gravitation* and Nature, but by these they could never have acquir'd their present regular Form and Situation. The six principal *Planets* revolve in Circles *Concentrick* with the *Sun*, in the same Direction of their Motion, and in the same Plane nearly: The

The ten *Moons* or *Satellits* revolve about the *Earth*, *Jupiter* and *Saturn*, in *Concentrick* Circles, and the same Direction of their Motions, in the Planes of the *Orbits* of their *Planets* nearly. But these regular and comely Motions could not arise from *Mechanical* Causes, for the *Comets* move in *Orbits* extremely *Eccentrical*, and in all the Points of the Compass, which it is impossible they should do, did they revolve by the same *Mechanical* Causes, by which the *Planets* move: it is absolutely impossible once to imagine, the Parts of Light, and the other Fluids of our *System*, should have been form'd by the Laws of *Mechanism*. In a word, one single *Atom* of Matter, in its original Production and internal Constitution, is not to be explain'd from these Principles; and if the wisest Philosopher now being, will give a satisfactory account of any one Portion of the whole *System* of Creatures, from these Principles, as to its original Production and internal Constitution, I will, for the sake of this, give up the whole Cause; and yet to satisfie himself, he ought to account for the whole from them.

§ X. The Production of Animals is altogether inconsistent with the Laws of *Mechanism*. 1. The Blood is squeez'd by the Force of the Heart from the left *Ventricle*, through the Arteries unto the Extremities of the Body, and is thence return'd by the Veins into the right *Ven-*

*Ventricle*; thence by the *Arteria Pulmonalis* unto the *Lungs*, from the *Lungs* by the *Vena Pulmonalis* to the right *Ventricle* again. The Motion of the Heart is caus'd by the nervous Fluids, acting some how upon or with the Blood in the *Muscular* part thereof. And these nervous Fluids seem to be both deriv'd from the Blood, and forc'd into the *Muscular* part of the Heart, by the Motion of the Heart it self, the Texture of their containing Vessels, and perhaps by the Pulsation of the Arteries upon the Nerves in the Brain. Here now the Heart is the Cause of the Motion of the Blood in the Arteries, and the Motion of the Blood in the *Arteries* urging their Juices through the Nerves, is the Cause of the Motion of the Heart, which is a plain *Circulation* of *Mechanical* Power, *i. e* a *Perpetuum Mobile*; which by what was said in the preceeding *Chapter*, is contrary to the Laws of *Mechanism*. If an *Epicurean Philosopher* could contrive a *Water Machin*, that the *Water* should move the *Machin*, and the *Machin* the *Water*, so that the same *Water* should constantly return in a Circle to move the *Machin*; I should then think their *Scheme* somewhat feasible: But since the first is demonstrably impossible, the latter must be so likewise. 2. In all Animals there are *Organs* in number actually indefinite, if not infinite. By an *Organ* I mean a distinct independent part of a *Machin*: Thus a Wheel, and all its Parts,

Parts, is an *Organ* of a Watch, if I may speak so; and a *Gland* with all its parts, or a Canal from its Origin to its Extremity, is an *Organ* in an Animal Body. Now these Organs, or independent Parts in the Animal, are infinitely many, as is evident both from the Nature of *Sensation* and *Nutrition*. *Sensation* is perform'd by the mediation of an *Organ* arising from the Brain, and continu'd through the Part affected. Now there is not the least imaginable solid part of the Vessels or Muscles but is sensible, and therefore the Organs in Animals that convey this Sensation, are infinite in number. To this perhaps it may be objected, that one *Organ* may convey *Sensation* thro' several places, and consequently, tho' every minute part of the Body be sensible, it will not follow, that the Organs which convey this *Sensation* are infinitely many, since they may all be only the continuation of some few Organs through different Parts. But the Answer is obvious, if every Point of the Vessels and Muscles of the Animal Body be sensible, then the *Organs* which convey the *Sensation* are infinitely small, and if infinitely small they must be infinitely many, seeing their Extremities in the Brain constitute a finite *Superficies*, or fill a finite Space; for a finite Number of infinitely small Parts, can never make a finite Quantity. Again, *Nutrition* is perform'd by an Organ, through which the Supply is convey'd to the Place to

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be nouriſh'd; and ſince there is no part of the Body that may not be increas'd or diminiſh'd (as is evident from the Cure of Wounds in all Places through which the neceſſary part of the Fluids of the Body can paſs) it is plain, that every individual point of the Animal Body is the Termination of an *Organ*, through which the *Nutrition* may be convey'd. Moreover, ſeeing even the Canals themſelves do increaſe in bulk, may decay and be impair'd, every aſſignable Part of theſe Canals muſt be the Termination of ſome *ſecretory* Duct, ſeparating a Fluid fit to increaſe their Dimenſions or repair their Loſſes; and theſe ſecretory Chanels again, muſt have others to increaſe *their* Bulk or repair *their* Loſſes, and ſo on *in infinitum*. Add to all theſe, that the fineſt Glaſſes diſcover nothing in the ſeveral parts of the Veſſels and Muſcles but fine ſlender Canals, and the better the *Microſcopes* are, the greater Number of thoſe capillary Pipes are diſcover'd; and theſe Parts, which were formerly reckon'd *Parenchymatons*, are now found to be bundles or heaps of exceedingly ſmall Tubes or Threads. The Muſcles themſelves conſiſt of a number of Fibres, and each Fibre of an incredible number of little *Fibrils*, bound together and divided into *little Cells* or *Veſicles*: The *Glands* are nothing but a *clew* of *little ſlender Pipes*, diverſly roll'd or folded together: The *Brain* is a numberleſs *Congeries* of infinitely ſmall Tubes, wo-

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ven into several Figures: The *Nerves* are bundles of small *cylindrical* Pipes; and the *Lungs* and *Liver* are but Heaps of little Bladders, upon which the Blood-Vessels are spread in Net-work, or of little Glands among which these Vessels are dispers'd. In one word, all the solid Parts of the Body are nothing, but either very fine exceeding small Tubes for the conveyance of some Fluid, or slender Threads in Bundles ty'd together by others surrounding 'em, or going from one Fibre to another, or spread out into thin Membranes: For the *Bones* are nothing but such Bundles, and all the Membranes or Membranous Coats of the Vessels, are nothing but these Threads wrought together into thin Skins. From all which it is beyond dispute, That every Animal is made of Organs in Number really infinite. For these Organs become at last infinitely small, and so their Sum must be infinitely many, seeing it constitutes a finite Quantity. Now how ridiculous is it to imagine a Thing so wonderfully made could be the Effect of meer Chance, or of the blind Laws of Motion. In *Artificial Machines*, the more complicated and compounded the Contrivance of the Parts is, the greater the difficulty is in adjusting them; and the difficulty increases in the same proportion the *Complications* do, and consequently, when the *Complications* are infinite, the Machin is altogether above the Power of *Mechanicks*, and

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quite impracticable by the Laws of *Matter and Motion*: But this is exactly the preſent Caſe, and therefore the Production of an Animal is altogether *immechanical*. 3. Allowing Animals might have been produc'd by the caſual concourſe of *Atoms*, why do not theſe very ſame Cauſes continually operate, and why do we not ſee the ſame Effects in our Days (ſince the Cauſes continue the ſame) that were beheld in former Times? If any of the *Philoſophers* ſhould ſhew us ſuch an Appearance, nay, if they would but tell us (without running upon Contradictions) how ſuch a *Machin* might be produc'd, we might begin to hearken to their Pretences. But ſince ſuch a Thing was never ſeen nor pretended, it's very arrogant in them to think People ſhould believe the Matter, without any Reaſon, upon their meer Word. No Body now-a-days, that underſtands any thing of Nature or *Philoſophy*, can ſo much as imagin, that any Animal, how abject ſoever, can be produc'd by an *equivocal Generation*, or without the conjunction of Male and Female Parents, in the ſame, or in two different Individuals. And very few, who have conſider'd the Matter, but own, that every Animal proceeds from a preexiſtent *Animalcul*; and that the Parents conduce nothing but a convenient Habitation, and ſuitable Nouriſhment to it, till it be fit to be truſted with the Light, and capable of receiving the Benefit of the Air. We know ve-

ry well, that there is nothing in the *Animal-Machin* but an infinity of branching and winding Canals, fill'd with Liquors of different Natures, going the same perpetual round, which are no more capable of producing the wonderful Fabrick of another Animal, than a thing is of making it self. Besides, in the *Generation* of an Animal, there is a necessity that the *Head*, *Heart*, *Nerves*, *Veins* and *Arteries* should be form'd at the same time, which can never be done by the Motion of any Fluid what way soever mov'd; for as hath been just now said, the *Heart* cannot move, unless Animal Spirits be sent from the *Head* through the *Nerves* into it: The Animal Spirits cannot be deriv'd into the *Heart*, unless the Blood be squeez'd by the *Heart* through the *Arteries* into the *Brain*. So that it is evident, that the *Head* and *Heart*, the *Arteries*, *Veins* and *Nerves* must be all formed at the same time, if the Animal is *Mechanically* produc'd: But this is altogether impossible; for no Motion of any Fluid or Fluids howsoever dispos'd, can form all these at the same instant; and we know all the internal *Mechanical* Actions of Animals, are perform'd by the Force of their Fluids. Let any one consider the *Infinity* of Canals, and other Organical Parts in an Animal; and again consider, that all that one Animal can conduce toward the *Generation* of another, is by the force of some Liquors through some Canals, and try

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if from this Power he be able to form the Idea of the *Generation* of an Animal It is doing Pennance, to read the wretched Accounts of the wiſeſt and moſt learned *Philoſophers* on this Head: To obſerve, how in every ſtep they contradict the known Laws of Motion; and indeed, the manner after which they would have 'em generated, is as much above the Power and beyond the Laws of *Mechaniſm*, as the true and genuin Manner and Method of their Production is. From all theſe Conſiderations it is evident, that an Animal cannot be produced mechanically; it is too hard a Problem to be ſolv'd from ſo few *data* as Matter and Motion; for indeed, could this one be once ſolv'd by any of the *Philoſophers*, we ſhould be eaſily ſatisfy'd of the reſt; tho' Plants, and all the vegetable Kingdom be liable to the ſame Difficulties, and furniſh us with the ſame Objections; for they are indeed only Animals of a lower Rank. And could it be once prov'd, either by *Demonſtration*, or by *Matter of Fact*, that a Plant or an Animal can be produc'd by *Mechaniſm*, *i. e* Nature, or the Laws of Motion, the thoughtful parts of Mankind would be eaſily tempted to believe, that ſince the better part was produc'd by Mechaniſm, the meaner, *i. e.* all the reſt of this viſible World, might have been form'd the ſame way. So that it is a Matter of the greateſt Conſequence, that we have demonſtrated, that neither Ani-

mals nor Vegetables can be produc'd *Mechanically*. There are many other Arguments which I can produce, to prove the same Proposition, which the Language I write in will not permit me to set forth.

§ XI. The *Spontaneous* Motions of the sensitive part of this *System*, is an eternal Contradiction to the Laws of *Mechanism*. We have sufficiently shewn, that neither *Spontaneous* (nor indeed any) Motion is essential to Matter; it is determin'd to one Direction (while in Motion) which it can no more alter than move of it self. This our Senses may daily inform us of: The Ball goes on in the Direction of the Stick, or of the Body of the Piece out of which it is shot; the Arrow in that given it by the Bowstring; and the Hand of the Dial-Plate in that given it by the Wheels; and that necessarily and constantly, if not forc'd out of the same by some foreign Violence: But all *Sensitive* Animals have a *self-motion*, can turn and wind, move thro' all the Points of the Compass, go back and forward, as their Occasions require, or Inclination prompts 'em. It's true, some of our Modern *Philosophers* have asserted, that the *Brute-Creation* are only Pieces of Clock-work, and all their Motions are as necessarily determin'd as that of the Hand on the Dial-plate; but this Assertion is altogether precarious, and maybe deny'd as easily as its alledg'd. Besides, the Demonstrations *à priori* I have just now brought

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to evince the contrary, the Obſervation and Experience of all Mankind contradicts it; the *Docility* and *Sagacity* of ſome Animals demonſtrate the contrary, and ſome *Brute-Animals* ſhew more Indications of it than ſome of the Race of Mankind on whom they beſtow it. What more evident Proofs of a *ſpontaneous* Motion could theſe poor Creatures give than they do, if they were really ſuppos'd to be endow'd with it? Nothing but a Senſation in our ſelves of the *Principle* of their Actions could create clearer Evidences of a *ſpontaneous* Motion. Beſides, it is altogether impoſſible to account for the far greater part of their Actions and Motions from *Mechaniſm*, as we have in the preceding Propoſitions ſhewn at large. And we ſhould be ſtrangely ſurpriz'd, if by any Combination of material Organs, we ſhould produce the ſmalleſt part of their Actions and Paſſions. Wherefore, ſince the ſenſitive World is endow'd with *ſpontaneous* Motions, and ſince this is far beyond and above the Powers of Matter, it is evident this Univerſe could not have been produc'd *Mechanically*.

§ XII. The *Voluntary Motions* of Rational Creatures are altogether unaccountable from the Laws of *Mechaniſm*. Muſcular Motion is perform'd much after ſuch a manner as this: (If the moſt probable of our Modern Conjectures in this Matter have any Certainty in them) the Muſcles are Bundles of Fibres, which

being closely compacted at both ends, terminate in their two *Tendons*, each of which is inserted into some one fix'd part of the Body or other: Every one of these Fibres consists of a prodigious number of lesser Fibres, or *Fibrils*, which are so many very slender elastick Canals bound about by small transverse parallel or Spiral Threads, which divide these hollow *Fibrils* into so many elastick *Cystes* or *Vesiculæ*, as if a Gut were ty'd at equal Distances. Into every one of these *Vesiculæ*, an Artery, Vein, and Nerve enter; the two first to bring and carry back the Blood, the latter to carry thither likewise its proper Fluid or Spirit; which mixing in the *Vesiculæ* with the Blood, produces a Rarefaction (the manner how, for avoiding Disputes, I shall forbear at present to determin) whereby these *Vesiculæ* are distended, and their *Longitudinal Diameters* (from Knot to Knot) straitned, and so the length of the whole Muscle shortned. The Nerves are the *Excretory* Ducts of the *glandulous* Substance of the Brain, and consequently, are much of the same Nature with the other *Excretories* of the Body, which are nothing but small slender slips of the Arteries, for deriving an appropriated Juice or Spirit from the Blood. Wherefore, since the nervous Juice or Spirit is form'd out of the Blood, and since the Nerves are very small arterial Tubes this Spirit very probably must move in these Nerves after the same manner the Blood does in the Arteries, only with this difference, that it

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moves abundantly more ſlow (its Velocity being abated, either by the many Circumvolutions of the Artery in the *Gland*, which is the Origin of the Nerve, or by the reſiſtance the Juice meets with in the ſlender Pipe of the Nerve it ſelf). If the *Circulation* of the Blood be admitted, and all the Juices of the Body be allow'd to be deriv'd from it, 'tis impoſſible that any of theſe Juices ſhould ſtagnate in their Veſſels longer than till they be fill'd; and therefore, the nervous Juice in its Chanels is propell'd after the ſame manner and by the ſame Mechaniſm the Blood is urg'd forward in the Arteries. Now in the Muſcles of involuntary Motion, ſuch as the Heart, the Lungs, the Stomach and Guts, and the muſcular Coats of the Veſſels, this nervous Juice or Spirit is conſtantly derived by a *Mechanical* Neceſſity. In the Heart, while the *Auricles* are full of Blood, they are diſtended, and the influence of the nervous Juices into their Muſcles thereby ſtop'd; but when once this Blood begins to flow into the *Ventricles*, the reſiſtance ariſing from the diſtenſion of the *Auricles* to the influx of the nervous Juice is taken off, and ſo it flows into the muſcular Subſtance of the *Auricles*, and thereby they are contracted while the *Ventricles* are diſtended, and the influx of the nervous Juice into their Muſcles is thereby ſtop'd, till the Blood be deriv'd into the *Aorta*, and the Impediment from this diſtenſion to the influx of the nervous

Juice be taken off, and so the *Ventricles* come into Contraction; which hinders the Blood from running any more into the *Ventricles* from the *Auricles*, and then the *Auricles* are again filled: And thus, by a *Mechanical* Necessity, they act *alternately*, the *Auricles* and *Ventricles* being as it were *Antagonists* to one another; so as that while these are distended those are contracted, the distension of the first permitting the influence of the nervous Juices into the latter; and so on the other hand. After the same manner are the *muscular* Coats of the Blood-Vessels, and of the Coats of the other Vessels containing Liquors deriv'd from the Blood, *alternately* contracted and dilated; for by the Contraction of the Heart the Blood is thrown into the Arteries, which distends them, and so the influence of the nervous Juice into their Muscular Coat is hindred; but when the Blood is by the *impetus* it has conceiv'd, deriv'd into the Veins, this impediment is taken off, and the Muscular Coats of the Arteries then act, the *Membranous* by their *Elasticity* concurring. In the Lungs the Gravity of the *Atmosphere* forces the Air into the small orbicular Vesicles thereof, and dilates the Cavity of the Breast; whereby the pressure of its sides upon them, and the Nerves that act in this Function is taken off, and so the Muscles of the *Diaphragm* and the other concurring ones are at freedom to act, and to distend the Cavity of the *Thorax*, till the

the preſſure of the ſides of the Breaſt become too ſtrong for theſe oppoſite combin'd dilating Cauſes; and then by their own Gravity, and the elaſtick Force of the Ribs, they fall down and compreſs the Lungs, and ſhut up the Emiſſaries of the Nerves. So likewiſe in the Stomach and Guts, when the *Longitudinal Muſcular* Fibres are in Action, the *Tranſverſe* and *Spiral* ones are relax'd by the preſſure of the acting Fibres upon the Emiſſaries of the Nerves of the relax'd ones; and ſo on the other hand, when thoſe are relax'd theſe are in action, and univerſally in all the *involuntary* Motions there is a *Mechanical* Neceſſity for the derivation of the nervous Juices into the Muſcles employ'd in theſe Motions. But in voluntary Motions there neither is nor can be any ſuch Mechanical Neceſſity, it being a plain Contradiction to their Nature; and therefore voluntary Motion is quite contrary to the Laws of *Mechaniſm*; we can move our Hands and Feet how and when we pleaſe in an inſtant, we can bend and unbend 'em as we will; there is no *Mechanical* Cauſe imaginable to force this nervous Juice into the Muſcles of voluntary Motion, and no Motion can follow unleſs this Juice be deriv'd; as is plain from hence, that cutting the Nerves that ſerve any Muſcle, tho' all other things continue the ſame, yet no Motion will follow. And the only Conception we can form of voluntary Motions is, that the Mind, like a skil-

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ful *Musician*, strikes upon that Nerve which conveys Animal Spirits to the Muscle to be contracted, and adds a greater Force than the natural to the nervous Juice; whereby it opens its Passage into the Vesicles of which the Muscular Fibres consist, which it could not have done by its natural Power. But this Action of the Mind or Will upon these Animal Spirits, being altogether unaccountable from the Laws of Motion, it is plain, that voluntary Motion is altogether *Immechanical*: And indeed, were it *Mechanical* it could not be Voluntary; for whatever acts *Mechanically*, acts constantly and necessarily, and so can never act voluntarily.

§ XIII. That *Freedom* and *Liberty* of chooſing or refusing which we find in our selves, is altogether inconsistent with *Mechanism*. Some Men indeed deny that we have any Free-will at all; but these need only examin their own Consciences to be convinc'd of their mistake; they will find, that even when their Reason would determin 'em to do such a thing, they have in their Power to forbear it, or to do the contrary; they can rise or sit still, go backward or forward, to shew their own *Freedom*; they can chuse the Time and Place, the Degrees and Circumstances of all these Actions that are called Free It's true, some of our natural Actions are neceſſary, but these which are commonly call'd voluntary Actions, are as much free as the nature of things will permit them.

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Their Power being limited, I would gladly know, what greater *Indications* of Freedom they could wish to have, than they now have. The Passions of Mankind (which in most determin their Actions) are indeed violent, but they have it in their Power to suspend for some time the satisfying of them; which shews, they are not necessarily determin'd toward their Satisfaction; for the Action of necessary Agents can only be suspended by a Miracle. Let us suppose, that Man, in a perfect state of Health, is free, and has a Power of *Election*: The only *Indications* he could give of this Freedom are, by doing the contrary, where there are weighty and solid Reasons for doing such a thing; or by making an *Election* among many things, when there is no imaginable Reason to determin him more to one than another; or to be able to suspend the effect of natural Actions, when without this interposition they would *Mechanically* operate. Now it's certain that we are capable of giving all these *Indications*, to shew our Freedom: We have it in our Power to hurt or even destroy our selves, tho' there be the best Reasons in the World to hinder us from so doing, we can take out the one and not the other, in two or more of the same things in all Circumstances alike: Tho' *Respiration* be reckoned an involuntary Action, and tho' it is certainly perform'd *mechanically* and uniformly, yet we have it in our Power to keep in our Breath,

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and to suspend the efficacy of this natural *Function* for some time; and this seems to be one of the most evident *Indications* of Freedom that can possibly be desired: For tho' in other Cases it may be alledg'd, that it is the subtil and *imperceptible* manner after which we are determined, that makes any of our Actions seem free, yet in this Instance that Objection can have no place; for if we are determin'd ever so *imperceptibly*, it is by the Necessity of Nature we are determin'd. Now it is absurd to think, that Nature should determin any natural *Function* to be perform'd regularly and constantly the same way, and that by *Mechanical* Laws, and at the same time determin this *Function* to be irregularly and uncertainly suspended. On the other hand, if we are necessarily determin'd in all our Actions, and if we have no Freedom, it is absolutely impossible we should make any Election among things in all Circumstances alike; for if we are determin'd, it can only be from the things themselves without us, for all things within us are, upon this *Hypothesis*, to be suppos'd to move uniformly and *Mechanically*. Now where the things without us are in all Circumstances alike, we can never be determin'd to any one of 'em by themselves; and therefore were we not free, we could never make an Election among things altogether alike. By things altogether alike, I mean such as are alike as to all the Circumstances necessary to

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conſtitute them the things requir'd. Thus two Farthings are altogether alike, tho' they may differ in ſome ſmall Circumſtances that do not concern the *Eſſence* of that *Species* of Coin. Thus 1, 3, 5, 9, are equally odd Numbers, and 2, 4, 6, 8, are equally even Numbers, and if 'twere propos'd to aſſign an even or odd Number, there are infinitely many which are equally ſuch. The ſame thing happens in the Anſwers to all theſe *Problems*, which are call'd *indetermin'd*; and in aſſigning one of the Anſwers to any ſuch *Problems*, there is nothing in their Nature that can poſſibly determin us, the Conditions of the Problem being had reſpect to; and therefore ſuch things as theſe are only pitch'd upon by the energy of our Wills or Freedom. In a word, *Freedom* conſiſts not in doing any thing, or every thing, for thus even the *Supreme Being* is not free, it being impoſſible for Him to do Evil; but in varying and diverſifying infinitely different ways, the Manner and Circumſtances of what may be done, and chuſing without conſtraint, or from any Motive foreign to the Party chuſing. But no Arguments will make a Man confeſs he feels, if he be obſtinately reſolv'd not to confeſs it: now Liberty is a thing felt, and is only to be found by a *Reflection* on our ſelves and our Actions; but there is one Argument which will always have weight with the wiſer and better part of Mankind; and that is, that without Free-will, Virtue and Vice, Juſtice and Injuſtice are only bare

bare Words. Now if Rational Creatures be free, as most certainly they are, this Freedom is a plain downright Contradiction to *Mechanism*, for *Mechanism* produces all its Effects necessarily.

## CHAP. IV.

### *Of the Eternal Production and Duration of this present State of Things.*

§ I. HAving, I think, sufficiently shewn the Inconsistency and Impossibility of the *Epicurean Scheme*. I come to the second Opinion about the *Origination* of the Universe; which in few Words tells us very positively; "That this present state of Things has been "from all *Eternity* of it self, so as we now "behold it; and that any Changes that have "have happen'd therein, have proceed-"ed from the Laws of *Mechanism* that now "obtain in the World." This *Scheme* consists principally of these two Parts. 1. That this World has been for *ever* in the State we now behold it. 2. That it has been so for *ever* of it self, independent of any other Cause. This Opinion is commonly, but falsly ascrib'd to *Aristotle*, not as its first *Broacher*, but as its ablest *Patron*. But tho' *Aristotle* held the first part of it, *viz.* That the World was from all *Eternity*, as we now behold it, yet he did not think it was so *of it self*; and there is a very great

great difference betwixt allowing this preſent *Syſtem* of the *Univerſe* to have been created from all *Eternity* by an *Omnipotent Cauſe*, and believing it to have been for *ever* of it ſelf without any *Cauſe*. My Deſign in the following Diſcourſe, is not to diſpute againſt any *Scheme* of thoſe who admit the Exiſtence of a *Deity*; I intend only to ſhew, That this preſent ſtate of things could not have been from all *Eternity*, neither of it ſelf, nor without the frequent and particular interpoſition of a *Divine Power*, and to make it plain, that naturally, and of it ſelf, it tends to *Diſſolution*: Tho' in the mean time, it is not to be doubted, but that that *Almighty Power* which could create this *beautiful Syſtem* of things, can preſerve it in being as long as He pleaſes.

§ II. That this Univerſe could never have been from all *Eternity* of it ſelf, in the preſent Condition it now is, is evident from hence, that it requires an *extrinſick Principle* for its ſubſiſting in its preſent Condition. If one ſhould ſee a Piece of *Clock-work*, pointing out the Diviſions of Time exactly and regularly, he might have ſome Difficulties about the manner of its Production; but if he ſhould ſee or learn, that it requir'd ſome *Foreign Aſſiſtance* to keep it going, that its Motion depended upon ſome Principle without it ſelf, that it requir'd winding up of the Spring or Weights, he would be ſoon ſatisfy'd it could not have been from all

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*Eternity* of it self in the state he then beheld it. Now this is the very Condition of the *Earth*, the *Moon* and *Planets*, and of all the *Celestial* and *Terrestrial* Appearances: Their Motions and Actions depend upon a Principle quite *extrinsick* to Matter, which arises from none of its Powers or Properties, as has been shown in the former *Chapter*. The Power which produces and preserves their Motions, springs from something without themselves; and if this Power were suspended or withdrawn, they would immediately stop, and their Motions would be destroy'd, and they would become a lifeless unactive heap of Matter. And this Power is nothing else but that universal Law of *Gravitation*, which *actuates* the whole Frame of all the *Systems* of Bodies, which proceeds from a Source both independent of, and distinct from Matter and all its Faculties. Wherefore, it is altogether impossible this present state of things should have been from all *Eternity of it self*, since at present it cannot subsist in a regular and beautiful *System*, without the perpetual influence of some superior and *extrinsick* Power.

§ III. When one thing depends upon anorher thing, as its *Cause*; as also, when one thing is necessarily requir'd for the Existence or Preservation of another thing, these can hardly be suppos'd to have been from all *Eternity of themselves*; but much more likely seem to imply

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Counsel and Design, and consequently, to flow from the Wisdom and Power of some *Intelligent* Being: For *Self existence* necessarily implies Independency, as to Existence on any other thing, either as Cause or as Effect; (I mean only of those things which are about us, *viz.* the visible things of this World, which have but Qualities both finite in Number and Degree; and consequently, have *assignable* relations to, and dependences upon one another; for it is otherwise in the *Immense Being*, in respect of his Creatures, which can have no proportion to Him, and He no dependence on them) and when a thing depends upon another thing as its Cause, this implies, that the first thing exists that the second *may exist*; which supposes Design and Contrivance, and consequently is a sign of Production or Creation, and not of the Self-existence of these things. Likewise, when a thing is necessarily requir'd for the Existence or Preservation of another, it plainly implies, that the first thing exists that the second *may exist*; which likewise supposes *Design* and *Contrivance*, and consequently, can be no sign of *Self-existence* in these things. Now is there any thing more plain, than that most of the things in this our *System* are necessary or useful towards the Being or Preservation of *Mankind?* Remove the *Sun* from us, or us from the *Sun*, the Earth could bring forth no Fruits for our Support; take away the *Moon*, the

*Seas* would stagnate and the Fish be destroy'd level our *Mountains* we should have no fresh Waters; destroy our *Atmosphere*, or the Air's Elasticity, we should swell like poison'd Rats: Do not these, and a thousand other Instances I could alledge, demonstrate, that all the Beings of this Universe exist as the necessary Effect, or for the Existence or Preservation of other Beings, and consequently, imply *Contrivance* and *Design*; which is a most evident sign, that all these things have been produc'd, and are not Self existent. If a wild *Scythian* or *Indian*, who never saw a House in his Life, should meet with a *noble Palace*, neatly finish'd and finely furnish'd, and about it should find Creatures that could not subsist without such a Convenience, and should plainly discover, that the Accommodations and Conveniencies of this *Building* were exactly suited, in every Circumstance, to the Wants and Necessities of these Creatures; I think he would have no difficulty in concluding, that this House was built by some wise *Architect* for the Convenience of these Creatures, he would certainly never dream, that it had for ever been there of it self so as he then beheld it. Now this is the very Case betwixt us, and the *System* of things about us: They have all relations and regards to us in our present state, and to one another; there is a regular Subordination and Subserviency among all the Parts, they all conspire to great

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and beneficial Ends: In a word, There is not so much as a supernumerary, superfluous or useless *Atom* in the whole great and complicated *Machin* of the Universe; every Age discovering new *final* Causes, and every the least Object displaying some new Utility or Beauty, to those *who seek out the Works of the Lord, and take pleasure therein:* So that it is impossible, that those who with due Preparation apply themselves to them should ever think they could be of themselves, or did not owe their Being to an *All-wise* and *All-powerful* Original. Not that the whole *System* of the Universe was contrived for the Race of Mankind alone; but that since their Utility and Conveniency being so plainly and fully consulted, in their present state, there can remain no doubt, that the whole *System* of Beings has been equally provided for in this wonderful Contrivance.

§ IV. That *Animals* could not have been from all *Eternity* is plain, for both the Reasons alledg'd in the two former *Sections*. For, First, Their Production and Existence depend upon Principles quite extrinsick from, and independent of themselves, I mean of their *Material part*. I have formerly shown, that they can neither subsist, nor be produc'd by the Powers of *Mechanism*; but for both require the constant influence of a Principle, even different from that which governs the inanimated part of the Universe, *viz. Gravitation*. Now all that

is observable in this World (according to this *Scheme)* is Matter and Motion (for if we once allow a Power distinct from these, we ruin this *Hypothesis*; for we do not then know how far the influence of this Power may reach, as to the Production and Preservation of the present state of things.) But the Production and Preservation of *Animals* is above the Powers of Matter, as has been formerly shown; and therefore, since they depend upon a Principle distinct from, and independent of the Laws of *Mechanism*, and need a continual influence of some Principle, distinct from Matter and its Properties, they could not have been for ever of themselves. Secondly, All the several Parts and Organs of the Animal Body, are so prudently adapted to the Benefit of the whole *Compositum*, as plainly implies Design and Contrivance, that it is impossible to consider this, and imagin they have been Self-existent. How wisely are the *Bones articulated?* How prudently the *Muscles* contriv'd, and how conveniently fastned to the several Places of the Body to produce the necessary Motions? With what Judgment are the *Arteries*, *Veins* and *Nerves* ranged? With what Wisdom are their Fluids dispos'd in their proper Vessels? How carefully is the Propagation of the *Species* provided for, according to several Circumstances arising from the particular Climate and Element each *Animal* is confin'd to, and how justly is every

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Particular adapted for the benefit of the whole Compound? I shall have occasion to pursue these Instances farther hereafter; but any Body who is ever so little acquainted with the *structure* of an *Animal*, cannot but discover evident Footsteps of *Design and Contrivance* in it, and therefore Animals cannot be Self existent. These, with the preceding Considerations on this Head, make it very improbable, if not impossible, the present state of things should have been for ever of themselves, without an *Omnipotent* and *Omniscient Original*. I come in the next place to those Considerations that seem to imply, That this present state of things is naturally, and of it self, tending to Decay and Dissolution, and consequently, that it must of Necessity have had a *Beginning*.

§ V. It has been formerly shown, in *Section* XXVIII of the preceding *Chapter*, and its *Corollary*, that some part of the Nourishment of *Animals* and *Vegetables*, and the greatest part requir'd to the Production of *Minerals* and *Metals* is a watry Fluid, impregnated with some other Body, which, by proper Operations upon this Fluid, is chang'd into a solid Form, of which but a very small part is ever resolv'd into Water again, whereby the quantity of Water on this our Globe is daily impair'd and diminish'd; wherefore, if the World had lasted from all *Eternity* in the State it now is, we had long since wanted both salt and

fresh Water. This Decrease of watry Fluids on our Globe is so considerable, that Sir *Isaac Newton* makes one use of *Comets*, in regard to us, to be to supply the Earth and other *Planets* with proper Materials for this purpose: For as the *Sea* is absolutely necessary for the present State and Condition of our Globe, that from it, by the *Sun*'s Heat, Vapours may be so plentifully rais'd, that being collected into Clouds, they may fall into Rains, so as to water and nourish the Earth, for the Procreation of *Vegetables* of all kinds: Or being condensed on the cooler Tops of Mountains, may fall through their Chinks into Basons and Reservatories, form'd by their hollow and open Texture, and thence into Rivulets and Rivers. So likewise for the Supply and Preservation of the *Sea*, and other Fluids in the *Planets*, the *Comets* seem requisite, from whose condens'd Exhalations and Vapours, whatever Liquor is spent on Vegetation and Putrefaction, may be supply'd and restor'd; for all the Vegetables are nourish'd constantly by almost Liquids only, and from putrify'd Liquors there is a Slime constantly falling: Hence the Quantity and Bulk of dry Earth is continually increasing, and the Fluids, if they were not supply'd elsewhere, would perpetually decrease, and at last fail. Now whereseever the Decrease of the Fluids be fix'd, whether in the *Planets* or *Comets*, it's plain they do decrease in this our

*System*,

*Syſtem*, and conſequently, had the World laſted from all *Eternity*, they muſt have fail'd e're now; for had the *Planets* wanted a regular Supply, ſince it is evident they have their Fluids continually turn'd into dry Earth by Vegetation and Putrefaction, had the World laſted from all *Eternity*, they had been more parch'd and dry than the Deſarts of *Arabia* 'ere this time. But ſuppoſing their Supply regular from the *Comets*, and let theſe *Comets* be as many as you pleaſe, leſs than infinite, yet ſtill, had the World laſted from all *Eternity*, theſe *Comets* muſt have been drain'd of all their Fluids, had they been nothing but Globes of Water, whereas we know they are Maſſes of ſolid dry Matter, like the *Planets*, with large groſs *Atmoſpheres*: So that it's evident, the liquid Subſtance in this our *Syſtem* of Bodies is continually decreaſing; which ſeems to imply, that this preſent ſtate of things is not ſo contriv'd as to laſt for ever, and ſo could not have been for ever.

§ VI. It has been prov'd likewiſe in the preceding *Chapter*, That the *Light* of the *Sun* does daily decreaſe, and that the Body of the *Sun* does continually grow cooler; the ſame may be ſaid of the *fix'd Stars*: Now had the *Sun* and *fix'd Stars* been from all *Eternity*, we ſhould have been reduc'd long before this time to a ſtate of utter Darkneſs. We are very certain, that the Rays of the *Sun* are impriſon'd in our *Plants* and *Vegetables*, in our *Metals* and *Mine-*

*rals*, and are retain'd by the Action of Bodies upon Light; and some part of them by their Separation from others, and their being imprison'd in these Substances, and the Action of Bodies upon Light, are for ever hinder'd from returning to the Body of the *Sun*; even supposing it were possible, that any Rays emitted from that *Luminous Globe* could return thither again, which is not very probable, they being projected with such a Force and Velocity, and retain'd by the *Attraction* of Bodies, where any oppose their Course, and proceeding for ever in their *Rectilinear* Direction, where no Bodies obstruct them. We are certain likewise, that the *Fountain* of our Heat daily impairs; that the vast Body of the *Sun* is perpetually a-lessening and a-cooling; not only by the fuming away of his Parts, but by the nearer Approach and stronger Action of *Comets* in their *Perihelia*, which carry off great Portions of his Heat and Substance. It is very probable, that these Specks and Clouds which appear and disappear on the Face of the *Sun*, are Vapours which fume away, and fill the Spaces through which the *Planets* move, or are *attracted* by their *Atmospheres*; and the *Comets*, by their so near approach to the *Sun*, so as to enter into his *Atmosphere*, must, without all doubt, carry off considerable Portions of this Substance; insomuch, that Sir *Isaac Newton* is of Opinion, that these *Comets* may at last fall into his Body, to rekindle and sup-

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ply the Waſte: and that thoſe *fix'd Stars* that have diſappear'd, and now appear, may be ſuch-like *Suns*, rekindled by the Approach of a *Comet*, juſt returning with the fiery Spoils of the *Sun*. And tho' theſe Effects be not ſo conſiderable, as to become ſenſible in three or four thouſand Years (tho' if ancient Hiſtories be true, this abatement and diminution of the Light and Heat has not been inſenſible) yet, in an infinity of Ages (this diminution being ſtill ſomewhat) the *Sun* had been reduc'd to the Heat and Light of a Taper long 'ere this time; and we had been involv'd in a more than *Cimmerian* Darkneſs. But ſince we obſerve no ſuch Effect as this, it is plain the World has not laſted from all *Eternity*.

§ VII. But that which does infallibly demonſtrate, that this preſent ſtate of things both had a beginning, and that of themſelves they muſt have an end, is, That our *Earth*, the *Planets*, the *Sun* and *fix'd Stars* do not move in Spaces altogether void, but in ſuch that do make at leaſt ſome reſiſtance to their Motions, I have ſhewn in the preceding *Chapter*, that the Reaſon why, for example, the *Planets* move about the *Sun* is, that the Body of the *Sun* attracts theſe *Planets*, and likewiſe theſe *Planets* attract the *Sun*; and that (ſince the *Planets* deſcribe *Elliptick* Orbits about the *Sun*) the attractive Force of the *Sun* upon the *Planets* is *reciprocally*, as the *Squares* of the different diſtances

ces of the *Elliptick* Orbit from the *Sun*'s Center in its *focus*. But that besides, these *Planets* were driven at first, or at the beginning of their Motion (to speak so) by a Force whose Direction made an Angle with the attractive Force; or that at the very same time the attractive Force of the *Sun* exerted it self on these *Planets*, they were push'd along in right Lines, by a Force whose Direction was in some manner or other inclin'd to that of the Direction of the attractive Force of the *Sun*, otherwise they could never have revolv'd in Orbits. So that it's evident, the Motion of the *Planets* about the *Sun*, is compounded of two different Motions in two different Directions, either of which being destroy'd, the *Planets* must have fall'n into the *Sun*, or stray'd for ever in right Lines; and tho' the resistance of the *Medium* cannot alter the *Centripetal* Motion, (so I call that whereby the *Planet* tends towards the *Sun*) yet if there be any resistance in the *Medium* through which the *Planets* pass, the *projectil* Motion (so I call the other) must decrease and (in an infinity of Ages) be destroy'd. Sir *Isaac Newton* has indeed demonstrated, that the *Celestial* Spaces thro' which the *Planetary* and *Cometary* Globes do move, must be void of all gross material Fluids, which might make any sensible resistance to them: For since all Fluids resist according to their Densities, or in proportion to the Matter they contain, as has been

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already mention'd: And ſince no ſenſible reſiſtance has been obſerved to the Motion of the *Planets* and *Comets*, but that they freely move through the Mundane Space, on all Hands, and in every Point of the Compaſs, without any ſenſible diminution of their Motion, of neceſſity the Spaces muſt be void of all groſs and ſenſible Fluids: Yet in the preſent Argument, unleſs theſe *Celeſtial* Spaces could be demonſtrated to be abſolutely and *Metaphyſically* void, in an infinity of Ages, ſome even ſenſible Reſiſtance muſt have been made to their Motions. I readily grant, that the preſent Frame of things is ſo wiſely contriv'd, that they may continue in their preſent Order, and obtain their appointed Ends for ſome thouſands of Years, without any ſenſible Alterations, and that their Uſefulneſs and Advantages do not depend on indiviſible Points. But when infinite Duration is the Queſtion, the Argument is conſiderably, if not infinitely alter'd. There are many Reaſons for ſuſpecting the *Celeſtial* Spaces, through which the *Planets* and *Comets* move, not to be abſolutely void *Light* is a Fluid, as has been demonſtrated, and paſſes from the *fix'd Stars* to us, and from us to them, and through all the ſeveral *Syſtems*. The *Sun*, very probably, throws out ſome part of his Clouds and *Atmoſphere* on the *Planets*; the *Atmoſpheres* of the *Planets* are elaſtick, and tho' doubtleſs very rare at great Diſtances from the

the Surfaces of their Globes; so as that a *Sphere* of Air of an Inch *Diameter*, of the same Density as it is at the Surface of the Earth, if 'twere expanded as much as the Air is at the height of a *semidiameter* of the Earth, would much more than fill all the *Sphere* within the Orbit of *Saturn*: Yet still being elastick, they may transmit some thin Vapours into one another, as very probably they do, by all their (not altogether insensible) Actions on the *Animals* on our Globe. The *Comets* send Steams and Vapours from their Tails, sufficient to supply the Expences of the Fluids in the *Planets*, as has been just now mention'd. All of them, *Planets* and *Comets*, have some secret Influences and Actions upon one another, even different from the bare Action of their *Attractions*; all which make it very probable, if not demonstrable, that these Mundane Spaces are not absolutely devoid of some extremely thin and rare Fluid, whose Action, tho' not sensible in any finite time, must have been sufficient, in an infinity of Ages, to have destroy'd the *projectil* Motion; and consequently, long 'ere now all the *Planets* and *Comets* had been broiling in the *Sun*, had the World lasted from all *Eternity*; which not having happen'd, it's plain this present state of things has not lasted from all *Eternity*, in the Order we now behold it.

§ VIII. The real, tho' insensible Changes and Variations that happen to the *Celestial* Bodies

dies in this our *Syſtem*, in reſpect to one another, in their Motions, Bulks, and mutual *Attractions*, amount to a convincing Proof, that the preſent ſtate of things was not intended to laſt for ever, and conſequently, could not have been from all *Eternity*. The Regular Deſcription of equal *Areas* in equal Times in the *Moon* (on which all the Philoſophy of her Motions and Appearances depend) is ſomewhat diſturbed by the Action of the *Sun*; beſides innumerable other Variations in her *Theory*, which have not all as yet been intirely collected or adjuſted: All which pretty nearly happen to the *Satellits*, with reſpect to their *primary Planets*: *Jupiter* and *Saturn* diſturbing each others Motions near their Conjunctions; and theſe two greater ones diſturbing the Motions of the leſſer, *Mercury*, *Venus*, the *Earth*, and *Mars*; ſo that their *Aphelia* are continually changing in a progreſſive Motion forward. The reaſon why the *Comets* move not in the *Zodiack* as the *Planets* do, is, that in their *Aphelia* they may be at the greateſt Diſtances from one another, and conſequently, may diſturb one another's Motions the leaſt that may be, by their mutual *Attractions*; notwithſtanding which they ſo far diſturb one another's Motions, as ſcarce ever to return in the ſame Orbit, or in the ſame periodical time exactly. That the Motions of the *Planets* are, or may be diſturbed by the *Comets*, in their return into the

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*Planetary System*, is, on the Principles laid down in the foregoing *Chapter*, past all doubt; the Decrease of the *Sun*'s Heat, Light and Bulk, and consequently, of his attractive Force, must at last lessen the mean Motion of the *Planets* about him, and consequently disturb, alter and change the whole state of the *System*. The Approach of some of the *Comets*, in their *Perihelia*, so near the *Sun*: the resistance they meet with in their Motion by the *Sun*'s *Atmosphere*, in so near an Approach; and the disturbance and retardation of their Motions they meet with in their *Aphelia*, by their mutual *Attractions* (being so large in Bulk and many in Number as Observations show them) all these Causes, I say, co-operating, must at last so weaken their Motion, and gradually bring them so near the *Sun* in their *Perihelia*, that they must at last drop into his Body, which must produce inconceivable Changes in this our *Planetary System*. The Vapours and Steams sent from the *Atmospheres* of the *Sun* and *fix'd Stars*, and from the Tails of *Comets*, may, on the Surfaces of the *Planets*, be chang'd into Water and watry Spirits, and then by a show of Heat, may be turn'd gradually into *Salts*, *Sulphurs*, Tinctures, Slime, Clay, Marle, Sand, Stones, *Corals*, and other Earthy Substances, and so increase the Bulk, Weight and *Attractions* of these *Planets* upon one another; and Dr *Halley*, by comparing ancient and modern Observations, has

has found, that the mean Motion of the *Moon*, compar'd with that of the Earth, is actually increas'd; which would seem to imply, that the Weight and attractive Force of the Earth is actually increas'd. Now tho' all these Changes be insensible in some hundreds or thousands of Years, and tho' they be regularly irregular (so to speak) and proceed from constant and uniform Causes, yet, in an infinity of Ages, backward or forward, they must have made, or must make such Changes in our *System*, as would not suit with the present Constitution of the animate or inanimate kind of Beings now existing; and plainly show the present state of things not calculated for *eternal Duration*, in the Condition we now behold 'em, and consequently, that they could not have been for ever as they now be.

§ IX. I have observ'd in the former *Chapter*, That the best Image or Idea we could frame of the *System* of the Universe was, as of a *noble* and *immense Machin*, form'd upon the strictest Principles of a *Divine Geometry*, the Whole, and its several Parts adjusted by Number, Weight and Measure, all conspiring towards, and regularly attaining some great and magnificent Ends, whose Springs are an immaterial Principle (if I may so call that of *Gravitation*) which animates the whole and all its Parts; an Original Impress, or a constant efflux from the Divine *Energy*, which enables the whole, and

and all the several Parts, regularly, constantly and harmoniously to attain their destin'd Ends and Purposes. There are certainly remaining, on all the Works of Nature, infinitely many and overcomingly strong and great Lineaments and Tracts of Wisdom, Contrivance and Design, so wonderfully beautiful and ravishing, that it must necessarily fill the Hearts of those *who take pleasure to search out the Works of God*, with Joy, Love and Veneration for their All-perfect Original. But there are many Suspicions arising from the present Constitution and Frame of the Universe; That it has already undergone, and may, for the future, undergo many Changes and Alterations from what it now appears; and consequently, that it has neither lasted from all *Eternity* as it now is, nor is likely to continue for ever in its present state. 1. Whatever else may be in this *System* of things, yet we are certain, its Parts and *Organs* are Material and Corporeal. Now it is not in the Nature of Material Organs to last for ever in the same state, especially if we join to this Consideration, that there is no perfectly solid and compact Bodies, but that all the Bodies we know of have interspers'd Pores and Vacuities, by which subtil Matter entering, must at last dissolve and destroy the Forms of Material Bodies; and the *Celestial* Bodies being, in reason, to be suppos'd of the same Nature with those about us, they must, in time,

time, moulder away, corrupt and change their Forms and Figures, and at last a sensible Alteration must be induc'd upon the Face of things thereby. 2. Whence soever the Motions of the *Celestial* Bodies did arise, or are continued, yet the Change on the solid Bodies of the *Celestial* Globes must make great Changes in their Motions: For tho' it were true (as it is much to be doubted) that no Motion is lost, yet if the Texture, Size and Solidity of the *Celestial* Bodies may be chang'd, there may such Changes ensue on the Constitution of the *System*, as may make it quite a different thing from its present state. 3. There are Suspicions, That the present *System* has undergone some considerable Changes (whether naturally or supernaturally is not the Question here) in respect of the present Set of Beings that inhabit, at least, our *Planet*. The Grossness, Opacity and Darkness at present on the Face of things, the dense and dusky *Atmospheres* about the *Planets*, the Inclemency of the Seasons, the Malignity in the Elements, the Poison in Animals, Vegetables and Minerals, all these seem to be the effects of some great Change induc'd on Nature, and not their State, as they immediately came out of the Hands of an infinitely wise, good, and powerful Being; and no Philosophy but that of *Christianity* can account for this, which acquaints us with the Degeneracy and Corruption of this present Set of Rational

Beings, in withdrawing their Love and Desire from its proper Object, to wit, Infinite Perfection, and placing it on the Creatures, and thereby becoming gross, sensual, opaque, and irregular, and so rendring the Change of the then Constitution of things necessary. Add to these the *Elliptick* Orbits of the *Planets*, their *spheroidical* Figures, the Obliquities of their *Æquatorial* to their *Ecliptick* Planes, the ruggedness and deformity of their Surfaces, the Suspicions of some universal Change on the internal Texture, at least of our Planet, the distant wandring of the *Comets*, and the extinction and re-kindling of the *fix'd Stars*; all these, and many more, such as I could collect, seem in some measure deviations, from the Simplicity, Uniformity and Facility Nature would observe, if not forc'd out of her Measures, and are shrewd Suspicions, that some great Changes have been made upon the Original Frame of our *System* at least. Far be it from me from suggesting the least Hint towards lessening or depreciating the infinite Wisdom, Beauty and *Harmony*, undeniably appearing in all the Works of GOD: All I would insinuate is, that there seems to appear *Vestiges* of some Alterations in the Constitution and Frame of the Universe, (at least of that part of it which principally respects the Human Race) from its primitive Lustre and Beauty, and that *Paradisaical* State wherein our Holy Religion informs us it was origi-

originally conſtituted. The Scripture-Account of the Nature of glorify'd Bodies, and of the *Paradiſe of the Faithful*, as alſo, of the Labour and Groans of the whole Creation under its preſent ſtate, accounts for what one who ſoberly and attentively looks into the natural Pravity of his own Heart, or into the preſent (in ſome ſmall degree) Gloomineſs, Perplexedneſs and Diſtortion of our *Syſtem*, cannot help to obſerve. All which ſeems evidently to hint to us, that the preſent Conſtitution neither has laſted, nor is to laſt for ever.

§ X. If the *fix'd Stars* be not actually infinite in their Number, then this preſent ſtate of things muſt, of neceſſity, both have had a Beginning, and muſt have an End. It's certain theſe luminous Bodies do mutually *attract* each other, ſince it's abſurd to imagin Matter not to be of the ſame uniform Nature every where; and it's as certain, that they do not revolve about any common Center or Centers, ſince they have been obſerv'd never to have varied their Situations or Diſtances from each other. Now if they be finite in Number, the terminating Bodies of the material part of the World muſt be all free from Attractions towards the void part, and ſo muſt be all approaching towards the *common Center of Gravity* of the whole; and had the Frame of the World been eternal, they had long 'ere now all of 'em met there. *Space* indeed may be infinite in its extent, but

there is no imaginable Reason to believe the Number of the *fix'd Stars* is infinite, nor the material part of the Universe boundless, since we have very good Reason to believe, that the solid Substance has a very small Proportion to the Vacuities interspers'd even in our *System*, and that the Matter of this Universe is almost nothing in respect of the containing Space, as has been insinuated in the former *Chapter*. For since Space is infinite (as I shall hereafter demonstrate) and since there's a necessity of admitting of actual Vacuities, as I have formerly shown, it's plain, Matter cannot be infinite in its extent, since thereby it is not equal to *Space*. I very much doubt, whether a real and true Infinite, in its proper and strict Sense, can be greater than another; the several Parts of Relative or Creaturely Infinites (so I call those that are generated by an uniform, convergent, or divergent Series, *vide Chap.* 1. *Part* 2.) may have finite Proportions to one another, but true Infinite must be One only, to which nothing else can be equal. *Space* is infinite, as being the Place (to speak so) of the *Divine Ubiquity*, and having some Connexion with the true, sole and proper Infinite; but Matter, if it be infinite, must either be so by the Necessity of its own Nature, or by the Will of the *Creator*. Not by the Necessity of its own Nature, because then it must be every where; which being already demon-

monſtrated falſe, it's impoſſible it ſhould be infinite by the Neceſſity of its own Nature: For if it be true, that Matter is not every where, it is poſſible it might be no where; that is, it's poſſible it ſhould not be at all; and conſequently, it is impoſſible it ſhould be infinite by the Neceſſity of its own Nature. Not by the Will of the *Creator*; for then a Creature might be equal to its *Creator*, ſince the juſteſt Image we can form to our ſelves of the *Creator*, is Perfection, apply'd to abſolute Infinitude; and if abſolute Infinitude could be apply'd to a Creature, then no doubt Perfection might be alſo; ſo that then an infinitely perfect Creature might be poſſible, that is there might be two or more infinitely Perfects, which is a Contradiction. Beſides, could Matter be infinite, being of thoſe kinds of Infinites that have three Dimenſions; by the *Analogy* and Simplicity conſtantly obſerv'd by Nature in like Caſes, it muſt be ſimilar, and equal to the other actual Infinite, to wit, *Space*. Laſtly, Matter is limited, in its own Nature capable of actual Limitations and Diviſions, and ſeems properly deſign'd for the Limits of *Space*, which is, in its own Nature, unlimited; and conſequently, Matter ſeems not at all deſign'd to be infinite in its Extent. Now if Matter be not actually infinite, in a proper Senſe, ſince *Space* is ſo, and ſince the *fix'd Stars* are limited in their Bulks and Sizes, it

is impossible they should be infinite in their Number; for when the Sum is finite, and each single Part or Division of the Sum is finite, the Sum of the whole of such Parts cannot be infinite. It is true, we can assign no Reason for a limited finite Number of *fix'd Stars*, and it is not impossible, but that their Number may be as great as Created finite Matter can amount to, since all the Works of God are immense, and worthy of Him who is Omnipotent. But still they cannot amount to real and proper infinity in Number, since Matter seems not capable, in its own Nature, to be infinite, but design'd for the Bounds and Limits of infinite *Space*, and the Conveniency of the material grosser part of *animated* Beings, who seem not to be infinite in their Number. Now if the *fix'd Stars* be finite in their Number, or the material part of this Universe limited in its extent, the Bodies at the Limits of the material part being quite free from *Attractions* upon the side toward the infinite Space, must yield to the *attracting* Force of the Bodies toward the *common Center of Gravity* of the material part, and the *Boundaries* yielding, the Bodies next them must do so likewise, and so on even to the Center; for nothing but an equal *Attraction* on all Hands can keep the *fix'd Stars* constant in their Places, and nothing but an infinite Number rang'd up and down the infinite Space can be sufficient for this; where-

wherefore since it has been evidently demonstrated, that the material part of this Universe is finite in its extent, if the World had lasted from all *Eternity*, the whole Matter of this Universe had been long before this time amass'd in the *common Center of Gravity*, and had there made a lifeless Heap; which not having happen'd, it's plain this World has not lasted from all *Eternity*, nor can of it self continue to all *Eternity*. And it's not unlikely that the vast, if not immense Distances of the *fix'd Stars* from us and one another, has been design'd to retard this Effect, as long as the Designs of Providence may require.

§ XI. In the former part of this *Chapter*, I have demonstrated the impossibility of the *Mechanical* Production of *Animals* and *Vegetables*; and I shall have occasion in the following *Chapter* to make it evident, that every generated *Animal* is produc'd from a pre-existent *Animalcul* of the same *Species*, and that every *Vegetable* arises from a small Plant of the same kind. And it is impossible it can be otherwise, upon our Adversary's *Scheme* of admitting nothing but Matter and Motion; for if *Animals* and *Vegetables* cannot be produc'd from these (and I have clearly prov'd they cannot) they must of necessity have been from all *Eternity*; and consequently, that all the *Animals* and *Vegetables* that have existed, or shall exist, have actually been all included in the first of every *Spe-*

*cies:* Or, which is the same thing, that pitching upon any one *individual* of either kind, now existent, that all the *Animals* or *Vegetables* that proceed from it, were included in it; and it, with all these, was included in that one from which it proceeded, and so on infinitely backwards; and consequently, since there is no new Production, all that are, or ever have been of that *Species*, were once actually together included in one infinitely remote from this now pitch'd upon; and that any finitely or infinitely distant time (if they have so long existed) from their Generation or Production, all the *Animals* included in the first of every *Species* were there moving and living *Animalculs*, and all *Vegetables* included in the first of every Kind, were there actually growing and increasing small Plants. Now since every *Animal* and *Vegetable* has been prov'd to consist of *Organs* in Number infinite (tho' if the *Organs* of *Animals* be only finite in Number, it will as effectually serve our present purpose) it is absolutely impossible, any of the *Species* of *Animals* or *Vegetables* should have existed from all *Eternity*; for then their Number must have been infinitely many, and the *Animalculs* and small Plants, being *Organical* Bodies, and consisting of Parts, and those infinitely many too, and being all included in the first of every *Species*, or those infinitely distant from the present *Individuals*; these first ones of every *Species* must

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of neceſſity have been infinitely big, for infinitely many *Organical* Bodies, how ſmall ſoever, amaſs'd together in one Body, muſt make that Body infinitely big. It's true, that tho' an *Animal* or *Plant* conſiſts of an infinite Number of *Organical* Parts, yet their Sum, or the *Animal* or *Plant* is but of a finite Magnitude, either becauſe the laſt *Organs* are infinitely ſmall (as they really ſeem to be) or that infinite here is only meant in a general, or leſs rigorous Senſe, for indefinite, or ſo many that we cannot diſtinctly conceive their Number, or give a Reaſon for their Limits: But ſeeing theſe *Animalculs*, or *Seed-Plants*, in this Caſe muſt be finite, as conſiſting of Parts, tho' infinitely ſmall, yet infinitely many in the firſt Suppoſition, and of a finite Number of finite Parts in the ſecond Suppoſition; conſequently, had the World laſted from all *Eternity*, the firſt of every *Species* muſt have been infinitely big: So that unleſs we could admit the firſt of every *Species* of *Animals* and *Vegetables* to be infinitely big (and how abſurd ſuch an *Hypotheſis* is, I leave the Reader to judge) it is abſolutely impoſſible, that *Animals* and *Vegetables* ſhould have been from all *Eternity*; neither can I ſee how this Argument can be evaded, if we admit all *Animals* and *Vegetables* to proceed from pre-exiſtent ſmall *Individuals* of the ſame *Species*, included in the firſt of each kind. And it is impoſſible this can be otherwiſe, upon our Ad-

Adversaries *Scheme*, if the *Mechanical* Production of these be impossible, which I think I have clearly demonstrated.

§ XII. Had the World lasted from *all Eternity* as it now is, it is altogether impossible, but that *Arts* and *Sciences* must have been brought to a far greater Perfection than they have as yet attain'd. Let us take, for Instance, the *Mathematicks*: It is certain this Science has been more improv'd within these two hundred Years, than in all the time past before that, since we have any Records; and two or three hundred Years more, going on at the rate of those last past, may carry 'em to a height which we cannot now imagin. Now it is altogether impossible the Improvements already made should be lost, seeing they contain things so absolutely necessary to the *Accommodations* of Mankind; they will as soon forget the use of Houses and Cloaths, as the Advantages to be reap'd from this *Science*; wherefore, had the World *Eternally* been, this Science had been brought to its utmost Perfection long 'ere now. It may be alledg'd, that *Inundations*, *Deluges*, *Wars* and *Pestilences* might have destroy'd all the former Improvements, and then we should have been left to begin anew. As for *Deluges*, it is impossible they should have been Universal, *i. e.* Naturally and Mechanically impossible; for the only *Philosophical* Account of an *Universal Deluge* hitherto assign'd, *viz.* that of Mr. *Whiston*'s,

*ſton*'s, depends intirely upon the Principles of *Gravitation*, which have been prov'd not to be *Mechanical*, in the Senſe us'd by our Adverſaries: and ſince there cou'd be no *Univerſal Deluge* naturally, (and to allow a Principle above Nature, or the eſtabliſh'd Laws of *Mechaniſm*, is to yield the Cauſe) particular Inundations could never have been ſufficient to have obliterated the remains of Sciences, particularly of this one, which by Inſcriptions on *Medals*, by the Ruins of *Architecture*, by *Pillars*, *Inſtruments*, and *Machins*, might have been preſerved in deſpite of every thing but an Univerſal Conflagration. Beſides, it's meerly precarious, to ſay there have been Deluges that have done any conſiderable Damage to the whole Rational Creation, and may be deny'd with the ſame Reaſon it is affirm'd, ſince it is certain we have heard of none of any conſiderable Conſequence. It's true, there happen'd an *Univerſal Deluge* in *Noah*'s Days; but beſides, as I formerly ſaid, that this was not brought about naturally, we know not, if this and the other Sciences had arriv'd at any great Perfection before this Deluge happen'd. So that we are not certain, if the Perfection of *Arts* and *Sciences* has been much retarded upon this account. Wars and Peſtilences, it's true, have been and may be, but thoſe do not happen univerſally over the whole World at the ſame time; and there are always ſome

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Countries and many particular Persons who escape; so that it's impossible these things could have obliterated all the Remains of *Arts* and *Sciences*. I believe it almost impossible by any means, except *Annihilation*, or a general Conflagration, so to deface the Memory and Remains of all our modern Improvements, that some of 'em should not last at least ten thousand Years to come; and yet its certain we have no evident Footsteps of Improvements older than three or four thousand Years. In short, this Argument holds good against every thing but *Universal Deluges*; and to admit or suppose any such to have been, is to yield the Cause, since its impossible to explain such by the Laws of *Mechanism*, or to account for them by Matter and Motion as things are now settled; and to quit these, or to allow any thing to have happen'd contrary to 'em, is to admit *Powers* superior to them, which, for ought we know, might have produc'd that which they can now so powerfully alter. And tho' *Arts* and *Sciences* may have been at a stand for many Ages in some Countries, yet that is nothing to the whole Globe. For since that Principle which prompts some Men to improve *Arts* or *Sciences* they are inclin'd to, springs naturally in their Minds, according to the *Scheme* of our Adversaries, and is neither imprinted upon them, nor were the things themselves reveal'd to them by any superior

perior Beings; this Principle, in an infinity of Ages, without any *Universal Deluge*, or even any particular one of any great extent, must of Necessity have brought *Arts* and *Sciences*, and the other Accommodations of Life, to a much greater Perfection than we see they have now attain'd. From all which, duly weigh'd, it's plain this World has not *Eternally* been as it is now. And indeed, the Accounts of our Improvements answer very well to the time assign'd by *Moses* for the Creation of the World.

§ XIII. If the Number of any *generated* thing, which we behold on this Globe, does either increase or diminish continually, in any finite Number of Years how great soever, by any finite Number how small soever, then this World could not have been from all *Eternity*, in the present state we now behold it. For had it increas'd in any finite Number of Years how great soever, by any Number how small soever, long before this time their Number had been infinite; so that this poor *Mole-Hill* of a *Globe* had not been able to contain 'em: And had they decreas'd, their Number had been none at all, *i. e.* the whole Race had been extinguished. But since neither of these has happen'd, it's plain the present state of things has not been for ever. It's not easie to believe, for instance, that the Race of Mankind has been *ebbing* and *flowing*, without con-

considerable increases or diminutions, from all *Eternity*. We are certain *Wars*, *Pestilences* and *Diseases*, and the other means of Destruction, have not been fewer for these 300 Years bypast, than ever they been since we have had Records; and yet it's plain, the Number of Mankind has considerably increas'd in that time. Sir *William Petty*, from Observations on Births and Burials has discover'd, that in 360 Years the Mass of Mankind is doubled in these Countries. Had they thus increas'd from all *Eternity* in other Countries, all the *Planets* within our *System* had not been able to have contain'd them by this time; yea, if in many *millions* of Years they had but increas'd by an Unity continually, their Number had been infinite by this time. But it's plain, both the Number of Mankind, and that of other *Animals* and *Vegetables*, must have perpetually increas'd, if the World has been from all *Eternity* as it is at present. And since their Number is but finite at present, it's evident, this World has not been for ever as it now is. And indeed the present Number of Animals does answer very well to the common *Æra* of the Creation. These two last Arguments I have subjoin'd, not as conclusive Proofs of the Production of this present Universe in time, but as concurring Confirmations of the former Arguments.

§ XIV. Lastly,

§ XIV. Laſtly, How improbable is it, that this World ſhould have been from all *Eternity*? Is there any thing we ſee in any part of it, or even in the whole, that has any other Quality ſuitable to that *Cardinal* one of Self-exiſtence? We our ſelves are certainly the nobleſt part of this *Syſtem* we are acquainted with; and yet God knows how unfit any of us, or even our whole Race is, to have ſo extravagant a Compliment beſtow'd upon us as *Self-exiſtence*, when as we can ſcarce be ſaid to be at all, ſo very a Nothing our Lives are in reſpect of *Infinite Duration*. We might, with as much Reaſon, imagin Mankind *Omniſcient* or *Omnipotent* (which we know too well he is not) as *Self-exiſtent*; theſe Qualities cannot be ſeparated; where one is, all the reſt muſt neceſſarily be; for whoſoever is *Self-exiſtent*, muſt neceſſarily and independently be. *Neceſſarily*, becauſe depending only on himſelf alone for Being, he may be when and while he pleaſes: *Independently*, becauſe his Being, and all that's neceſſary to it, depend on himſelf alone. By *Self-exiſtence*, in its true and poſitive Senſe, I mean not only the not having a Cauſe of Being, which is but a Negative Quality, and concludes nothing Poſitive: But by *Self-exiſtence* here I mean *Self origination* (if I may ſpeak ſo) or a poſitive Quality in ſome Being, *analogous* to, or ſomething of that Kind; as a Power to give a Being to another is. It is true,

true, we have no adequate *Ideas* of *Infinity*, *Self-existence*, *Creation*, and the like, and in their common Acceptation these are only Negative Qualities; but they must have Positive Meanings, or Ideas, answerable to them, and must in some one Being imply active and positive Qualities, in their proper and genuine Sense, tho' we finite Creatures can form no Images of them; and therefore the positive Quality imply'd by *Self-existence*, in its proper and eminent Sense, must imply Activity, Power and Knowledge: For *Self-existence* apply'd to an inanimate thing is a Contradiction, a self-existent Body is as impossible as a self-moving Body; for a thing to owe its Being only to it self, must imply more than meer Existence, it must necessarily involve Power, Activity and Knowledge. *Vide Chap. 2d. Part 2d.* And consequently, whoever necessarily and independently exists, must Be, in opposition of all others; and whoever is so, must be able to preserve his Being in despite of all other Powers, *i. e.* must be *Omnipotent*: Whoever is *Omnipotent*, must know all things that are possible to be done or let alone; for he can never be suppos'd to do that which he knows not how to do, *i. e.* must be *Omniscient*; and whoever is *Omnipotent* and *Omniscient*, all things else must depend on him; for being so, he may make all things depend of him, if already they did not so. Besides, other things must depend

depend of him for the very ſame Reaſon, *viz.* becauſe he can make 'em do ſo. As alſo, whatever is *Omnipotent* and *Omniſcient*, depending on nothing, and having all things depending on him, muſt be ſupremely good and wiſe; becauſe he knows all things, can do all things, has no Reaſon nor Cauſe to determin him to any thing that's bad, ſince nothing can hurt him, nor any Power annoy him. So that it's very plain, that whoever is *ſelf-exiſtent* muſt poſſeſs all the other ſuitable Qualifications. And ſince we muſt of neceſſity admit ſomething to be *ſelf-exiſtent*, how much more reaſonable is it to believe, that that *immenſe Being*, which poſſeſſes all other Qualities ſuitable to that of *Self-Exiſtence*, has been from all *Eternity*; and when it was his Pleaſure, has created this noble Repreſentation of himſelf, *viz.* This beautiful State of things, which bears ſo viſible *Characters* of his infinite Power and Wiſdom, as ſhall abundantly be ſhewn hereafter. And this is the *third Opinion* about the *Origination* of the Univerſe, which muſt of neceſſity be true, ſince after the other two, which I have (I think) abundantly confuted, this is the only poſſible remaining Choice.

## CHAP. V.

### *Of the Existence of a Deity.*

§ 1. THAT there are no *Speculative Atheists*, to me seems as evident, as that no Body who has consider'd the Matter, can be absolutely convinc'd, that the three *Angles* of a *Triangle* are not equal to two *right ones*. The *Fool* indeed, *may have said in his Heart there is no God, i. e.* lewd and vicious Men may have heartily wish'd within themselves, that there were no secret Observer, nor that there might be any publick *Punishment* of their Crimes, because it's their Interest there should be neither: But that a Man of an ordinary Understanding, who has seriously set about the matter, and has duly weigh'd the Evidences for the *Being of a Deity*, should at last come to a full Persuasion of his *Non-Existence*, to me seems as impossible, as it is for one who has attentively read the first Book of *Euclid*, and rightly understood what he has read, to be convinc'd, that the Sum of the *Angles* of a *right lin'd Triangle*, can be more or less than two *right Angles*. It is true, most Men think nothing

nothing of the matter, and few give themſelves the trouble to enquire, whether there be a God or not; they think ſuch idle *Speculations* become thoſe only who know not how to live, and to make the beſt uſe of Life that may be. And of this kind of *Atheiſts* there is abundance in the World; for its certain we can never determin any thing about what we never or but very *ſlightly* think; and there are millions who live and die ignorant of many Self-evident Truths, becauſe they never took the pains to conſider them. But the being or not being of a Deity, is a Matter of that Moment to the Government of the World, the neceſſary Conſequences thereof do ſo nearly concern the Happineſs or Miſery of every *individual rational Creature*, and the Objects that inculcate the Conſideration of it are ſo many, ſo different, and ſo *conſpicuous*, that none but the wilfully blind can withſtand ſuch convincing Teſtimonies. Now tho' the *Demonſtration* of this *great Truth, viz.* that there is a *ſupreme Being*, who made and governs this preſent *Syſtem* of things, has employ'd the Care of many *wiſe* and *good* Men, ſo that none can doubt of it for want of ſufficient Proofs, who will but give themſelves leave to conſider; yet ſince the *Evidences* for it can never be too many, and ſince ſome are to be wrought upon by one ſort of Argument, others by another, I ſhall here ſet down thoſe which agreed beſt with my manner of think-

ing, which are founded on the *Principles* of a juster *Philosophy*, and a more genuine Explication of Nature, than was known till of late. And I have chosen this way of Reasoning, the rather because our modern *Atheists* have taken *Sanctuary* within the Bounds of *Natural Philosophy*.

§ II. All the Arguments of the *preceeding Chapter*, are so many Proofs of the Existence of a *supreme Power*, who made and governs this present *System of things*. For since this World could neither be produc'd by the casual *Concourse* of *Atoms*, neither could have been from all *Eternity* it self, as it has been sufficiently prov'd; and since that it now is no body doubts, of Necessity therefore it must have been produc'd or created, some time or another, by some pre-existing Power. Now since there is nothing else in being but *this World*, unless we admit that *supreme Power* we are now speaking of; and since it could neither have been produc'd from the *fortuitous concourse of Atoms*, nor have been from all *Eternity* of *it self*; it must of necessity have been produced by that *supreme Power*, whose Being we now inquire into. Since then this *supreme Power*, of necessity must have created this beautiful *System* of things, and since existing independently, He must for ever be, and have been; therefore that *great Power* must necessarily now exist. All the Difficulty any rational

onal Creature can have about the Existence of a *Deity*, is how to conceive his having for ever been of himself without a Beginning. Now if we could avoid this Difficulty, by saying, that this *System* was produc'd by the casual meeting of *Atoms*, or by alledging it to have for ever been of it self, we might have some slight pretence for our *Infidelity*. But since this Difficulty does equally lie against all these three Suppositions (for if the World has been produc'd by the *casual concourse of Atoms*, then *a Void*, *Atoms*, and *Motion*, have for ever been, without a Beginning, of themselves; if it has been from all *Eternity of it self*, as it is, then the Case is plain, that we must allow something to have been without a beginning *of it self*) wherefore I say, since the very same Difficulty equally and unavoidably urges all the three Suppositions; is it not more reasonable and *congruous* to allow that Being to have been for ever of it self, without a beginning, to whom we may ascribe, and who does necessarily possess all other suitable Perfections, rather than either of those others, which we know are neither endow'd with, nor capable of such eminent and transcendent Qualities? I will not say with *Des Cartes*, that because in our Conception of a Being *infinitely perfect*, there must be included *necessary* Existence, that therefore such a Being must of necessity *actually* exist. But sure I am, since our

main Difficulty in the Conception of the Existence of a Being *absolutely perfect*, is his necessary Existence, or his having for ever been of himself, without a beginning; it is much more reasonable to suppose that Being to have for ever been of himself, who necessarily possesses all other suitable Qualities, than those who neither possess, nor are capable of any of 'em.

§ III. The *Existence* of *Matter* is a plain *Demonstration* of the *Existence of a Deity*. I believe no body doubts, that there now exists a quantity of *solid Mass*, out of which the *celestial and terrestrial* Bodies were form'd; and tho' perhaps in our most solid Bodies there be more Pores than Parts, or more *Vacuity* than *Solidity*, yet there is still sufficient, not to permit us to doubt of the Existence of Matter. Wherefore since Matter now actually is, whence or how came it first to *be*? It could never have been of it self, since we are certain, that it is destitute of all *active* Qualities whatsoever. And *Self-Existence*, in its proper and positive *Idea*, seems to involve (besides having no Cause for the Being of the thing to which it is apply'd) some other active Qualities, as Power and Knowledge, as I have already hinted. But we have already prov'd, that Matter cannot move of *it self*,, nor when put in motion can it rest of *it self*, nor of *it self* change its Course, nor alter its Direction; it can neither change its *Figure*, nor *Colour*, nor *Situation*; in a word, it is endu'd with no Property but Inactivity, which is a Negation. How absurd is it then,

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to imagin it could have brought *it self* into Being, when it can do just nothing *of it self*? To conclude, could Matter be Self-existent, even in the Negative Sense of the Word, it must necessarily have been; and if necessarily, it must, from the Necessity of its Being, have been ever, and every where, that is, it must be Eternal and Infinite; from which, it's plain, that it must have been every where *Uniform*, all Variety of Forms being a Contradiction to Necessity; it must have also been immoveable, for had it necessarily mov'd in any one Direction, with a determin'd Velocity, by the same Necessity it must have mov'd in a different Direction with a different Velocity, which being impossible, it could not have mov'd at all; for both these are such Contradictions to Sense and Reason, as none but an *Atheist* can swallow. We may as reasonably imagin, that *Non-entity* should bring it self to become a positive Being, as conceive it possible, that Matter should, of *it self*, for ever have been. Besides, admitting Matter to have been for ever of it self, yet this will not solve half the Difficulties arising in the Formation and Production of the present State of things, as has been shewn in the *preceding Chapter*, and shall be now farther illustrated. Whereas the admitting of an *infinitely Powerful and Perfect Being* to have for *ever* been, and to have created the *solid Mass*, and out of it to have framed this wonderful *System* of Things, contracts all the Difficulties of Nature into this one of his *Existence*. For as to the Difficulties of Cre-

ation, they vanish quite before *infinite* Power; for Power implies a Capacity to act, and *infinite* Power a Capacity to act every thing not involving a Contradiction. Wherefore since Matter now actually is, and yet it neither could have been for ever of it self, nor had it for ever been, would that remove the Difficulties arising in the Formation of this present *System of things*, but, on the contrary, would multiply 'em: is it not much more reasonable then, to admit an infinitely wise Being to have been for ever *of himself?* Whereby all the Difficulties, in the conceiving the Manner of the Production of this *Universe*, do vanish at once.

§ IV. It has been formerly shewn, that this *Universe* was not form'd by the same Laws it is now govern'd, and which its several Parts in their Actions do now obey; and therefore, of necessity there must have been some Power superior to, and distinct from that of Matter, which form'd this *System* at first, and prescrib'd Laws for its Parts afterwards to observe. We see all the Changes that now happen in this material World, are according to the Laws established in the *first Chapter*. But this *System* of Things could never have been brought into its present Order, by the now establish'd Laws of Nature (even admitting Matter to have been *eternally existent of it self*) as I have abundantly shewn in the *first Chapter*; neither one, nor all of these Laws were sufficient to have separated that thin and rare fluid of *Light*, from the other grosser and more dense ones, and amass'd it in

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the *Sun* and *fix'd Stars*; neither did the Laws of ſpecifick Gravity obtain in the *Formation* and *Situation* of the inner Parts of our *Earth*, and the other *Planets*; nor in the *Separation* and *Situation* of the ſeveral Fluids thereof. By none of the known Laws of Motion was the *Number*, *Magnitudes*, or Diſtances of the *fix'd Stars* determin'd. the Figure, Number, Denſities, Gravitations upon one another, Situations and Order of the *Planets* adjuſted. the Number, Diſtances and Magnitudes of the *Satellits of Jupiter*, the Form and Bulk of the *Annulus* of *Saturn* limited. In a word, the whole proceſs of the *Formation* of the *celeſtial* and *terreſtrial* World, as to their principal Parts and Arrangements, could be brought about by none of the Laws of Motion and *Mechaniſm*, that now obtain in this ſettled ſtate of things; or at moſt theſe Laws had but a ſmall ſhare in their Production. Wherefore ſince this beautiful *State of things* has not been for ever *of it ſelf*, nor could be form'd by the Powers and Laws of Nature, it is plain it has been produc'd by ſomething ſuperior to Matter and its Qualities: and conſequently, by that *ſupreme* Being, into whoſe *Exiſtence* we are now inquiring. And truly, from what has been here ſaid, and a great deal more of the ſame nature, alledg'd in the *firſt Chapter*, it is evident, we can have no Notion of the *Formation* of this preſent State of things, other than what we have of a *Planetary Clock*, or any other complicated *Machin*, form'd by the Hand of a skilful *Artiſt*; where tho' the Rules of

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Motion, and Laws of Nature may obtain, when it is adjusted and finished: the Parts of the *Machin*, their Figures, Sizes and Proportions, and the connexion and fitting the whole, was brought about by voluntary Operations, different from, and sometimes contrary to the Law of Nature and Motion, whereby it now subsists a regular *Machin*, and performs its intended Operations; which, nevertheless, it is not of it self able to perpetuate, without frequent interposals of the same voluntary Powers, and the removal of those Obstructions and Disturbances, Time, and the frail Nature of material Organs must bring upon it. And tho' this, no doubt, be but an infinitely low and faint Resemblance of that *noble* and glorious Work, yet it is the best and most adequate our *Imaginations*, without running upon evident Contradictions, can frame.

§ V. As the Formation and Disposition of the *great Bodies* of this Universe, did necessarily require the Hand of a Being infinitely Powerful; so likewise did their first Movement, and impress'd Motions, demand the Impulse of an Almighty Hand to set them first a-going. For supposing the *celestial* Bodies already form'd, and rang'd according to their several Distances from one another; yet without this Impulse, they had continued unactive, unmoving Heaps of Matter. Now it has been already shewn, that no Particle of Matter, nor any *Combination* of Particles can move themselves, and therefore it was absolutely necessary, that something different

ferent from themſelves ſhould put them in a Motion, with a due Velocity, along the *Tangents* of their ſeveral *Orbits*; otherwiſe they had for ever continued in the Places, and at the Diſtances they were at firſt ſet. Wherefore ſince it is certain, that theſe *glorious Bodies* have been rolling about theſe four or five thouſand Years; and ſince it hath been demonſtrated, that they are not ſelf-moving, being *ſolid Maſſes of Matter*; ſince it has likewiſe been ſhewn, that they have been ſet a-going by ſome powerful Hand; and what Hand ſufficient for ſuch a Work, but his who is Infinite, both in Strength and Skill? and conſequently, he who did ſo *great and glorious* Things muſt neceſſarily *be*.

§ VI. Not only the *Formation*, and firſt *impulſe* of the great Bodies of this Univerſe, along the *Tangents* of their *Orbits*, but their *Centripetal* impulſes, whereby their Revolutions, or *orbicular* Motions, are perform'd, did, and ſtill do, require a Power beyond that of Matter and the Laws of Nature, to the preſervation of their Motion. Sir *Iſaac Newton* has demonſtrated, that to the Motion of any of the *Celeſtial* Bodies in an *Orbit*, there is neceſſarily required two Impulſes, one along the *Tangent* of the *Orbit*, another toward the Center, about which the Body moves. The firſt being once impreſt, does continually perſevere, and needs no more to be renew'd, as is evident from the firſt Law of Nature: The ſecond continually draws the *celeſtial* Body from its *rectilinear* Motion, and forces it into a *curvilinear* Orbit, ſo that it muſt

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be repeated every Minute of Time. Now these *secondary* Impulses arise from that *Universal Principle of Attraction*, whereby every Particle of Matter, and all the Bodies of this Universe tend toward one another; and by which the *Sun*, being the far greatest Body of this our *System*, draws toward him the *Planets*, and they their own *Satellits*, and without which they would for ever wander in right Lines. But it has been demonstrated in the *first Chapter*, that this Principle, whereby the *Revolutions* of these glorious Bodies are perform'd, is independent of the Laws of *Mechanism*, and only accidental (no ways *essential*) to Matter, but implanted therein by some extrinsick Power, and consequently (since it must be repeated every Minute) must be perpetuated in it by some uninterrupted Influence, or by the persevering *Energy* of the first Impression. And seeing there is nothing in Nature, but Matter, and the Powers thereof, unless we admit that supreme Being for whose Existence we contend; therefore the Revolutions of the *celestial* Bodies, in their several *Orbits*, do necessarily infer the Existence of a Deity.

§ VII. The *Existence* of *Animals* does necessarily infer the *Existence* of a *Deity*; for it has been demonstrated in the *former Chapter*, that all Animals are, in their own Natures, *perpetua mobilia*, that they have some Principle above the Power of Matter that governs their Motions; it has likewise been shewn, that every *individual Plant* and *Animal* is a *Machin* of an infinite number of Organs; that no Animal is or can be produc'd

duc'd or generated by the Force of Matter and Laws of *Mechaniſm* (that all *Animals* and *Vegetables* that ever were or ſhall be, were all created, or form'd at once, as ſhall be afterward ſhewn) and that all theſe are abſolutely unaccountable from the Laws of Motion, and conſequently, muſt ſpring from a Principle independent of, and altogether above the Powers and Properties of Matter. Now whenever we forſake the Powers of Matter, and the Laws of *Mechaniſm*, we neceſſarily muſt have Recourſe to the *Exiſtence* of ſome Power ſuperior to, and independent of Matter, and all its Laws and Properties, and conſequently, to that *infinitely Perfect Being*, into whoſe Exiſtence we are now inquiring; ſince there is nothing beſides Matter and its Properties in the World, unleſs we admit the Exiſtence of that *ſupreme Being*.

§ VIII. The *ſpontaneous* Motions of *irrational*, and the voluntary Motions of *rational* Animals, the *Freedom of Will*, and liberty of chuſing or refuſing in the latter; and, in a word, all the *Appearances* of Nature, which are above the Powers of *Mechaniſm* (which are innumerable) are ſo many undeniable Proofs of the *Being* of a *God*. For ſince this preſent *Syſtem* of Things has not been from all *Eternity of it ſelf*, and ſince theſe are allow'd to be above the Powers of *Mechaniſm*, they muſt have been produced by ſome Power Superior to thoſe of *Mechaniſm*. But no Power is ſufficient for thoſe, but his *who alone does great and marvellous things*; who adjuſted all the Parts of this noble *Fabrick* by Number, Weight

Weight and Measure, and therefore he that brought about all these glorious things, *He who alone does Wonders*, must necessarily *be*.

§ IX. The Preservation of the *Being* and Faculties, both of the animate and inanimate Part of this *System* of things, does necessarily require the Power, and consequently, the *Existence* of a Being absolutely perfect, *i. e.* of a Deity. For since this *System* of things has not been from all *Eternity* of it self, as we now behold it; and since there is no necessary Connexion between the being of any one Part thereof, or of its Faculties, this present Moment, and their being the next; and since we see both have been preserv'd for a considerable time: This Preservation of the *Being* and Faculties of things can never be accounted for, without having Recourse to an *Almighty* Power, which may be sufficient for all things not involving a Contradidiction; and therefore that *Omnipotent* Being, endow'd with this Power, must necessarily *be*. It is true, Things (as they are now constituted by *infinite Power* and *Perfection*,) once brought into Being with such and such essential Qualities, may be suppos'd to persevere and continue in Being, and in Possession of their Qualities till some Cause destroy them, or alter their Natures; but, if we reflect upon the possible manner of their *now* Being, that is, the Preservation of their Being and Qualities, it can never be conceiv'd without having Recourse to an infinite Power. For either things now being, were for ever so: *That is*, were *self-existent, that is,* are necessarily existent, *that*

*is*, are incapable of Motion or Variety of Forms as I have formerly ſhewn, which is a Contradiction. Or they were brought into Being by an infinite Power; *that is*, had an active *energy* impreſs'd on them, to perſevere in their Being; *that is*, are continu'd in Being by Virtue of an *original Impreſs* from an *Almighty Power*; *that is*, owe neither their firſt Being, nor their Being *now*, to themſelves nor their eſſential Natures, but to an Almighty *Fiat*, which both produced them into Being, and impreſs'd on them a Power or Virtue to continue their Being, which, if poſſible, being ſubſtracted, they wou'd without any orher Cauſe ſink into their Primitive Nothing. Without all Peradventure, *the Works and Gifts of God are without Repentance*, they are all immortal and eternal in their Beings, and eſſential Natures, as partaking of his own *Immortality*, and being all of them, in a higher or lower Degree, *Images* and *Copies* of his Being and communicable Perfections; and tho' poſſibly he might have given them different Natures and Conſtitutions at firſt, from what they now have; yet being now conſtituted and form'd into ſuch Beings, it may be doubted whether he can deſtroy the eſſential Natures of Things thus conſtituted, *annihilate* theſe he has made, or eſſentially alter their Natures, without counteracting himſelf; which ſeems a Contradiction in infinite Perfection. There is no Doubt, they may paſs through infinite Varieties of *Forms* and *Modifications*; and this our *Syſtem*, or the *Syſtem* of the whole Univerſe, with all its Inhabitants, may be

be changed into greatly different Shapes and Modifications; yet their essential and *generical* Natures must be preserv'd and subsist for ever. Not by Virtue of their once being brought into *Existence*, which may be consider'd as a *Transient Act* that subsists no more, but by an active permanent Principle of *Immortality* (so to speak) which is communicated to them from the Divine Nature, as being his Images, and Emanations from him, whereby being once brought into Existence, they are enabled to continue in their Being and Natures. There is nothing more evident than that God cou'd create nothing but what shou'd be in a higher or lower Degree, an *Image* or *Copy* of his infinite Perfections. The Effect must have some Resemblance to the Cause, but this can never reach *Independence* or *Self-existence* in a proper and strict Sense, that were a plain Contradiction to *Creation* or being produc'd. So that Perseverance in Being in Creatures, cannot be the necessary Consequence of their Being, else being once produc'd, they wou'd necessarily continue in their Being, and become Independent for the Continuation of their Being, which is Inconsistent with the Nature of Creatures; but the continuance of their Being is, by a Virtue or *Energy*, deriv'd from the Divine Immortality, of which their being and persevering in Existence is a *Copy* and *Resemblance*; and as the Divine *Immortality* is not a dead inactive Principle, like a *vis inertiæ*, so neither is the Copy thereof in Creatures, but

but a living active Principle, which once impreſs'd, preſerves created Things in their Being and eſſential Qualities without the neceſſity of a continual Interpoſition. This may be more eaſily underſtood by comparing it with the Nature of *Attraction* or *Gravitation*, and with the Nature of Motion in Bodies. I think it pretty evident that *Attraction* is not eſſential to Matter as ſuch: For were there an univerſal *Plenum*, or no vacuities in the amaſſed finite Quantity of Matter now being, and no Motion (neither of which imply a contradiction) then matter might be conceiv'd without Gravity, or at leaſt, it's Gravity without effect, which in an active Principle, is much the ſame thing: And therefore it is highly probable that Gravity is a divine *Energy* impreſs'd on Matter. Of the ſame kind of Qualities, in Bodies, is Motion. And all the Motions in the Univerſe, not depending on *Attraction*, muſt have been originally impreſſed by a Cauſe different from Matter, ſince it has been demonſtrated that Motion is not eſſential to Matter. Now it is plain Motion is an *active Principle*, which is continued by Virtue of the firſt *Impreſſion* and is not eſſential to Bodies: After the ſame manner likewiſe may *Attraction* be conceived to be. And with due regard to the different kinds of Qualities, in a proper *Ana-*

*logy*, we may Reason concerning that Principle of self-preservation in all created things, whereby being once brought into Existence, they are enabled by virtue of the first *Energy* to preserve for ever their Being and essential Qualities. And universally we may reason thus in a proper *Analogy* about all the Copies, or *Images*, in the Creatures, of the particular Divine Attributes communicated to them, except *Self-existence* and *Independency*. They all, not being meerly *inertes potentiæ*, but Life and Activity being essential to them all, in a higher or lower degree. Now since this Principle of the *preservation* of their Being and Qualities, does not flow from the Nature of things when brought into Existence, (else they wou'd now being produc'd, exist necessarily) but supposes an *Energy* or active Principle communicated to them by which they continue to *be*; The Original of this communicated Principle, *the Great and Omnipotent Origin of all Being and Perfections* must necessarily *be*.

§ X. But that Argument for the *Existence* of a *Being infinitely perfect*, who made and governs this *System* of things, which of all others affects me most, is that it is altogether impossible, this Universe cou'd have been better contriv'd or more compleatly finished, than it is, had *infinite Wisdom* first actually design'd it, and then put the

Design

Design in execution. Or which is the same, there are legible and indelible *Characters* of *infinite Wisdom*, in the *Contrivance* of the whole, and of the several Parts of this admirable Fabrick of the *Universe*; and it is altogether impossible for the united skill of Men and Angels, to mend any one Part, or to contrive it better, or even to find out any real Defect therein, due Regard being had to the universal Benefit of the whole *System*; and to the particular Natures and Dispositions of the Inhabitants of it's several Parts. For in the Contrivance and Adjustment of the several Parts of this noble Machin, where the Choice is various, and sometimes infinite, that one is pitch'd upon, which alone cou'd bring, the most advantages to the whole, or which only cou'd bring about the design'd Effect. This is a very large Subject, and to treat it according to it's Dignity requires far greater Abilities than I am Master of, and more Room, than the Limits I have prescrib'd to my self will admit. However, I shall endeavour to illustrate the same in the following Particulars. But first of all it will be convenient to lay down a general *Scheme* of this noble Structure.

§ XI. Let us then conceive the *Mundan Space*, or the universal Place of all Bodies, to be boundless in it's Extent, or

indefinite in it's Dimensions, and in it at vast Distances from one another, the fix'd Stars (huge luminous Bodies, like the Sun) to be plac'd: Keeping always the same Distances from one another, and moving only (perhaps) about their own *Axes*; about each of these let us imagine several Bodies like our *Planets*, rowling in several *Orbits* at several Distances; and about those lesser ones, *Analogous* to the *Satellits* of our *Planets*. Each of these fix'd Stars with their Circumambient *Planet-like Orbs*, constituting that which is call'd a *System* of the *Celestial* Bodies. And how many such there must be in the vast extent of Space, a naked Eye in a cloudless Night, may give us some faint *Glimpse*, but much more a good large *Telescope* directed towards that Region of the Sky, which is call'd the *milky way*. Our Numbers fall very short here, and our *Arithmetick* can scarce give us an *Idea* of the vast Quantity of *Systems* that adorn this *stupendous* Piece of *Architecture*; and yet no doubt their Number is finite, and they are all included in a bounded Extension; for Matter seems not capable in it's Nature of being infinitely propagated. Moreover, let us conceive the glorious Body of the Sun, fix'd in the Center of Gravity (or near it) of this our *System*, and in the common Center of Motion

(or

(or *focus*) of all the *Planetary Orbits*. And then next to him *Mercury* ſhall make his *oval round*, but ſo near him, that we can rarely obtain a diſtinct View of him, he being ſwallow'd up almoſt in the Light of the *Sun*. Next to *Mercury*, is our beautiful Morning and Evening Star *Venus*: Next *Venus*, our *Earth*, with it's Attendant the *Moon*, perform their friendly Courſe, and meaſure out the Year. Beyond our *Earth* *Mars* ſingly and alone, revolves about the ſame Center; next to *Mars*, *Jupiter*, the largeſt of the *Planets*, with his four *Satellits* turn round in concert; and laſt of all, *Saturn* with his five Guards, and his ſurrounding *Annulus* or *Ring*, deſcribes the remoteſt *Orbit*, and concludes our *Syſtem*.

§ XII. For the eaſe of the Reader, in going through the following Parts of this Diſcourſe, I ſhall ſet down here the Numbers that repreſent the *Periods*, the *Diameters*, *Diſtances*, *Gravities*, and Quantities of Matter, in thoſe of the *Celeſtial* Bodies, which have afforded any Grounds for determining the ſame, as Mr. *Whiſton* has calculated moſt of them from the lateſt Obſervations, by Sir *Iſaac Newton*'s Rules.

*The Periodical Times of each Planet's Revolution about the Sun.*

| | | | Y. | D. | H. |
|---|---|---|---|---|---|
| *Mercury* | Revolves | | 00 | 088 | 00 |
| *Venus* | about | | 00 | 224 | 18 |
| The *Earth* | the Sun | in the | 00 | 365 | 06 |
| *Mars* | in the | Space of | 01 | 315 | 00 |
| *Jupiter* | Space of | | 13 | 000 | 00 |
| *Saturn.* | | | 30 | 000 | 00 |

*The middle Distances of the Planets from the Sun.*

| | | | | |
|---|---|---|---|---|
| *Mercury* | Is distant from the Sun. | 020952000 | Statute Miles each 5000 *Paris* Feet. | |
| *Venus* | | 039096000 | | |
| The *Earth* | | 054000000 | | |
| *Mars* | | 082242000 | | |
| *Jupiter* | | 280582000 | | |
| *Saturn.* | | 51354000 | | |

*The Quantity of* Matter *in, and the Gravity of such of the heavenly Bodies (as afford Means for the determining the same,) at the some distance from the Center of the Sun, is as follows,*

| | |
|---|---|
| The *Sun*'s | 66690 |
| *Jupiter*'s | 00060 $\frac{1}{2}$ |
| *Saturn*'s | 00028 $\frac{1}{4}$ |
| The *Earth*'s | 00001 |
| The *Moon*'s | 00000 $\frac{1}{28}$ |

*The*

*The Diameters of the Sun and Planets.*

| | | |
|---|---|---|
| The *Sun*'s | 494100 | Statute Miles each 5000 *Paris* Feet. |
| *Saturn*'s | 043925 | |
| *Jupiter*'s | 052522 | |
| *Mars*'s | 002816 | |
| The *Earth*'s | 008202 | |
| The *Moon*'s | 002223 | |
| *Venus*'s | 004941 | |
| *Mercury*'s | 002717 | |

*The Diameter of the Celestial Bodies in Englisb Measures.*

| | Diameter. | |
|---|---|---|
| The *Sun* | 822138 | English Miles. |
| *Mars* | 4875 | |
| The *Moon* | 2175 | |
| *Mercury* | 2748 | |
| The *Earth* | 7967 | |
| *Saturn* | 93451 | |
| *Jupiter* | 120653 | |

*The weight of Bodies on the Surface of the Sun and Planets.*

| | | |
|---|---|---|
| On the Surface of | The *Sun* | 10000 |
| | The *Earth* | 01258½ |
| | *Jupiter* | 00804½ |
| | The *Moon* | 00630 |
| | *Saturn* | 00536 |

*The Denſities of the Celeſtial Bodies.*

| | |
|---|---|
| The *Moon*'s | 700 |
| The *Earth*'s | 387 |
| The *Sun*'s | 100 |
| *Jupiter*'s | 076 |
| *Saturn*'s | 060 |

*The Periodical Times of the Satellits of Jupiter.*

| 1 | 2 |
|---|---|
| 1 d. 18 h. 28 $\frac{1}{5}$ | 3 d. 13 h. 17′ $\frac{9}{10}$ |
| 3 | 4 |
| 7 d. 3 h. 59 $\frac{1}{2}$ | 16 d. 18 h. 5′ $\frac{1}{3}$. |

*The Diſtances of the Satellits from the Center of* Jupiter.

| | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| *Flamſted* by the Eclipſes of the Satel. | 5. 578 | 8. 876. | 14. 159. | 24. 903 | Semidiameters of *Jupiter*. |
| From the Periodical Times. | 5. 578 | 8. 873. | 14. 168. | 24. 968 | |

*The Periodical Times of the Satellits of* Saturn.

| 1 | 2 |
|---|---|
| 1 d. 21 h. 18′ 31″. | 2 d. 16 h. 41′. 27″. |

4 d.

4 d. 13 h. 3 47′. 16″. 15 d. 22 h. 4 41′ 11″.

79 d. 7 h. 5 53′ 57″.

*The Distances of the Satellits from the Center of* Saturn.

1 2 3 4 5 } Diameters of the Ring of
$\frac{9}{40}$ $1\frac{1}{4}$ $1\frac{3}{4}$ $3\frac{1}{3}$ 12. } *Saturn.*

*The middle distance of the* Earth *and Planets compar'd with their Periodical Times.*

| | ♄ | ♃ | ♂ | ☉ | ♀ | ☿ |
|---|---|---|---|---|---|---|
| According to observation. | 954198 | 522520 | 152350 | 100000 | 72398 | 38585. |
| According to the Periodical Terms | 953806 | 520116 | 152399 | 100000 | 72333 | 38710. |

*The Times of the Revolutions of the Sun and Planets about their Axes.*

The *Sun* in 25 Days *Jupiter* in 10 hours
The *Earth* in 1 Day *Mars* in $24\frac{3}{5}$ hours
The *Moon* in 29 Days *Venus* in 23 hours.

§ XIII. What a *beautiful Scene* of things have we here? How simple, and yet how wonderful are the Works of Nature? Such like are all the Effects of infinite Wisdom, her Foundations are plain and simple, but her

her *superstructure*, various and wonderful. Her Causes few, her Effects innumerable. Her Course the easiest and shortest possible, and her Means the fewest that can possibly bring about her Ends. Let us but consult the Books of the old *Astronomers*, and we will then have sufficient Ground to admire the frugal Simplicity of Nature, in this neat compact *System*; we shall see there what sorry, perplex'd Work they made, with their *Cycles*, and *Epicycles*, their *carrying*, and *æquating*, their *Concentrick* and *Excentrick* Circles, their *Stations* and *Retrogradations*, their solid *Orbs*, and the perpetual Change of the *Axe* of Motion, in the celestial Appearances: Such a strange *ungeometrical* and contradictory *System* they made of the *Heavens*; whereas from these few plain and simple Positions, all the Appearances of the *Heavens*, are accounted for, with wonderful Consistency and Facility.

§ XIV. The *Sun* being a huge Body of *liquid Fire*, brought into fusion by the Force of his Heat, and thereby sending out *Oceans* of that thin, active Fluid, which is the *Medium* of Light, and the cause of all Heat, turns round his own *Axe*, from West to East in about twenty five Days; which arises from his first Being put into such a *Circumgyration*, after His having been seated in his Place. And there being little or

no

no Reſiſtance in his Region to retard his Motion, it has continu'd ever ſince, and will do, 'till the *Conſummation* of all things; by Virtue of that firſt impreſs'd *Gyration*, and the firſt Law of Nature. His Motion about his own *Axe*, has been diſcover'd by *Spots* on his Surface, and his Fluidity, from his leſſer Denſity in reſpect of ſome of the ſolid *Planets*, (ſome ſolid Bodies being more denſe than moſt Fluids are) his *Sphæricity*, and that all Bodies heated to ſuch a Degree, as the *Sun* muſt neceſſarily be, muſt certainly be *vitrify'd*. That is moſt continue in a Fluid State as long as this violent Heat laſts. Beſides, the Fountain being in reaſon to be ſuppos'd of the ſame Nature with the Streams, ſince the *Rays of Light* are moſt certainly a thin, rare, active Fluid: Much of the ſame kind, with due regard to the Circumſtances, muſt the Light in the Body of the *Sun* be; the greateſt difficulty is to conceive how this *Globe* of liquid Fire ſhou'd be able to project his Beams with ſuch Velocity and Force, ſo as to be able to diſſolve every thing almoſt. That which may contribute to help our Imagination here, is what may be daily ſeen at a *Smith's Forge*, when the Iron is ſo much heated, as to run into *Fuſion*, it ſends out copiouſly, on all Hands, Streams of *liquid Fire*: All *ſulphurous* Bodies likewiſe

wise emit and issue out *liquid Flames*, or burning Smoak, which by reason of the greater Gravity of the *Circumambient Atmosphere* is forced upwards, but if there were no *Atmosphere*, these Flames wou'd be projected every way equally. Now as *Bodies* act upon *Light* by emitting, refracting, and reflecting it, so *Light* acts on *Bodies* in heating them, and putting their parts in a vibrating Motion wherein Heat consists. And when their parts are thus heated, or put in *Vibrations*, beyond a certain Degree, they emit *Light*, and Shine, and this emission is performed by the vibrating Motions of the Parts. So that supposing the *Sun* a great Body like our Earth vehemently heated, that is having it's Parts set into vehement *Vibrations*, these *Vibrations* of the parts of the *Earth* wou'd forceably project, and violently thrust forth, immense *Oceans* of this subtile Fluid on all Hands. So that as Light produces these *Vibrations* on the parts of Bodies, these *Vibrations* in Bodies, are the cause of this emission of *Light* on all Hands. Every single particle in Bodies, when put in this vehement vibrating Motion propelling in it's turn and return of *Vibration*, a *Cylinder* of Light equal to it's Section tho' it's Center, and the Sum of all the particles of the heated Body urging so many such *Cylinders* on all Hands as is the Number

ber of ſuch vibrating Particles. The greater Quantity of Matter, and larger Dimenſions of the *Sun* in reſpect of the *Planets*, makes him ſufficient for all the Expenſes of Light, he lays out upon them, whereby his Bulk and Heat is conſtantly diminiſhing, as alſo, for drawing all the reſt of the *Planets* and their *Satellits* towards him; for as has been formerly inſinuated, the Force of *Attraction* of one Body upon ſeveral others, at the ſame Diſtance, is as their *Maſſes*, or Quantities of Matter: Wherefore ſeeing the *Sun* contains a greater Quantity of Matter by very far, than any of the *Planets*, the Sun muſt neceſſarily draw the *Planets* with their *Satellits* to him; which wou'd have unavoidably come to paſs, had not the *Planets* at the inſtant they were ſeated in their Places, receiv'd an impulſe, which drove 'em along the *Tangents* of their *Orbits*; and had not theſe two Motions been ſo exactly *Counterpoiſed*, that neither of them ſhou'd over-power the other. Theſe with the ſmall Reſiſtance they meet in their Courſes, and the Force of the Attraction diminiſhing as the Squares of their Diſtances increaſe, has made 'em ever ſince revolve in their *Elliptick Orbits*, in one of whoſe *Foci* the *Sun* is ſituated: And what is here ſaid of the Cauſe of the *Primary Planet*'s Motions about the *Sun*, may be underſtood of the *ſecondary*

*dary Planet's* Motions, about the *Primary ones.* All the *Planets* revolve about the *Sun* in *Elliptick Orbits*, or such as are not very far different from them; as also most of 'em, turn round their own *Axes* from West to East; the *Earth* in Twenty Four Hours, about an *Axe*, which is inclin'd to the Plane of the *Ecliptick* 66½ Degrees: And in it's Motion about the *Sun*, this *Axe*, of the diurnal Rotation, observes always a *Parallelism* with it self, the Reason of which is evident, for if a *Sphere* move about an *Axe*, this *Axe* (there being no other Motion suppos'd in the *Sphere*) is immoveable, while in the mean time every Point in the *Sphere*, describes a Circle about this *Axe*, and therefore if a *Sphere* move either in a *curve*, or strait Line, and at the same time turn round it's *Axe*, the *Axe* shall always continue *parallel* to that Line it was first *parallel* to; for that Impression which perpetuates it's Rotation upon it's *Axe*, and the impulse along the *Tangent* of it's *Orbit*, are two distinct Motions, which never interfere, and so each of them must continue the same as if the other were not; so that every Body turning about it's *Axe*, and at the same time describing a Right or *Curve* Line, must of necessity retain it's *Axe parallel* to it self, if nothing else disturb it. *Jupiter* likewise, *Mars* and *Venus*, and our Moon,

*Moon*, do alſo turn round their *Axes*, from Weſt to Eaſt, and would retain this *Paralleliſm*, if not diſturb'd by *Foreign* Violence. The *Satellits of Jupiter* and *Saturn* do likewiſe turn round their *Axes*, as is evident from hence, that they, like our *Moon*, turn conſtantly the ſame Face or *Diſk* toward their *primary Planets*; and it is not improbable, that the others in which we have not had the Occaſion of obſerving the like, may alſo turn round their *Axes*; that in a Revolution about the *Sun*, they may in all their Parts oftner than once, enjoy his Light and Heat; for it is from this Rotation of our Earth upon it's *Axis*, that we have the *Viciſſitudes* of Day and Night, and from the *Paralleliſm* of the *Axis* to it ſelf, in the *Earth's* Revolution about the Sun, and it's being inclin'd to the Plane of the *Ecliptick*, come the beautiful *Seaſons* of the Year, *Summer* and *Winter*, *Spring* and *Autumn*, which are of ſuch comfort and uſe to it's Inhabitants. From the *Opacity* of the *Moon* and *Planets* and their *Satellits*, and the *Obliquity* of their Planes to the Plane of the *Ecliptick*, together with their diurnal and annual Motions; and ſome of 'em revolving in *Orbits*, within one another, their *Phaſes*, their appearing and diſappearing, their total and partial *Eclipſes* ariſe.

§ XV.

§ XV. Since their *Solidity* and *Opacity*, the *Similar* Nature of their *Orbits*, and their *Satellitious* Attendance, their Revolutions about the *Sun*, and their Rotations about their *Axes*, their *Gravitations* and mutual *Attractions*, the Proportion of their Periods to their Distances from the Center of Motion, the *equable* Description of *Area*'s in equal Times. Since, I say, all these and many more particulars are exactly the same in our *Earth*, and the other *Planets* with their *Satellits*, it is not improbable that they may be alike in other things, and that they may have Inhabitants both rational and irrational, Plants and Vegetables, Water and Fire *analogous* to, tho' not of the very same Nature and Constitution with ours; and since our *fix'd Stars* are exactly of the same Nature with our *Sun*, as shall be afterwards made appear, it is very likely that they have *Planets*, and these *Planets* have *Satellits*, and these *Planets* and *Satellits* have Inhabitants, rational and irrational, Plants and Vegetables, Water and Fire, *analogous* to those in our *System*. On these Suppositions, which not only are not absurd or contradictory; but on the contrary highly probable, as shall be afterwards made appear more fully; what a noble and glorious *Fabrick* wou'd present it self to our Imaginations? How is it possible for any

one

one who had this *Idea* of the *Universe*, to think it possible such a beautiful *System*, cou'd have been produc'd without infinite Wisdom? None but the wilful, or obstinate cou'd resist such a powerful Impression of divine Power and Wisdom. On the other Hand, how is it possible to conceive that, that immense Number of glorious and Sun-like Bodies of the *fixt Stars*, those *vast* and huge Bodies of some of the *Planets* (in respect of our *Earth*) with their noble *Attendance*, were made for no other use but to twinkle on us in Winter Evenings, and by their *Aspects* to forebode what little Changes of Weather, or other pitiful Accidents were to be expected below, or to be peep'd at by some poor paltry Fellows of Astronomers? Or can any body force himself to think, that all *Animals* and *Plants*, have been exhausted in furnishing out this poor Corner, while the other more glorious, great and noble Parts, are left destitute and bare? Certainly they must have a great Opinion of themselves, and of their own Habitation, who can think so poorly of the rest of the Universe. It is true, from the great Resemblance, and *Analogy*, between the *greater material World*, and the *lesser* one, of an *Animal* Body; and from this *Hypothesis*, of *new Worlds*, and *new Setts* of Living Creatures, it's bearing hard, upon the no-

ble, and glorious *Oeconomy*, of the Redemption of lapsed Creatures: By confining it, to a *dirty Mole-hill* of a single *Planet*, some pious and enlight'ned Persons, have taught that as in an *Animal* Body, the *Brain*, the *Heart*, the *Lungs*, the *Liver*, the *Guts*, the *Spleen*, and all the *infinite Number* of *Conglobat* and *Conglomerat Glands*, had their several distinct uses, for purifying, refining, and exalting, the necessary Juices and *Spirits*, or for secerning, and throwing off, the noxious ones; and yet all this Complex and *infinite* variety of noble and wonderfully contriv'd *Organs*, were design'd solely, for the preservation of one *Animal* and the propagation of it's kind. So in the *greater material World.* All that *infinite* variety of *Stars*, and *Planets*, might be for purifying and subtilising, concocting and preparing the *Astral Influences* necessary for the *Preservation*, *Propagation* and *comfortable Support* of the several *Setts* of Creatures Inhabiting this spoil'd, defaced, and ruinous Globe of the *Earth.* Whatever may be in this I shall proceed in supposing, the *Planets* to be Inhabited, and that the *fix'd Stars* have their *Planets* and Inhabitants, yet they are not of the same Nature and Constitution with those of our Globe, as is evident from the different Degrees of Heat and Light they enjoy; as also from the different Vicissitudes

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of their Day and Night, and the Seasons of their Year. *Mercury* is three times nearer the *Sun*, than we, and consequently enjoys nine times as much Heat and Light, he never removing Twenty Eight Degrees from the vast Body of Light. *Venus* enjoys twice as much Heat and Light, and her Motion about her *Axe* is perform'd in Twenty Three Hours, and so her Day is but one Hour less than ours; she has all the *Phases* of our *Moon*, appearing sometimes horn'd sometimes halv'd. *Mars* has no Inclination in the *Axe* of his Rotation to the Plane of his *Orbit*, and consequently enjoys a perpetual *Equinox*, but no vicissitudes of Seasons; he receives but the third Part of our Light and Heat. *Jupiter* likewise enjoys a perpetual *Equinox*, and and a Day of Ten Hours, but receives only the Twenty Fifth Part of our Heat, and *Saturn* but the Hundredth.

§ XVI. The *Satellits* of the several *Planets* suffer many and various Disturbances in their Motions from the *Sun*, as also, the Primary *planets* suffer likewise from the Forces of the *Sun*, and of the secondary *Planets*. Thus the *Moon* (if acted upon only by the attractive Force of the *Earth*) wou'd by a *Ray* from the Center of the Earth, describe equal *Area*'s in equal times, wou'd about the *Earth* in one of it's *Foci*,

describe a perfect *Ellipse* of the same *Species* constantly, whose Plane wou'd be immoveable, or always the same, and whose Inclination to the Plane of the *Ecliptick* wou'd never vary; but by the Action of the *Sun* upon the *Moon*, all these Effects are disturb'd, for she neither describes equal *Area*'s in equal Times by a *Ray* from the Center of the Earth, but somewhat larger ones in her *Conjunctions* and *Oppositions* with the Sun than in her *Quadratures*. Neither is her *Orbit* always *specifically* the same, nor is the *Earth* in any of the *Foci* of her *Orbits*; for they are more *Curve* about the *Quadratures*, and less toward her *Conjunctions* and *Oppositions*: In every Revolution she describes a new kind of *Curve*, and both the Situation of the Plane of her *Orbit*, and it's Inclination to the Plane of the *Ecliptick*, varies every Moment, and all these Uncertainties and Aberrations, are multiply'd by her nearer or remoter Distances from the *Sun*, besides a great many other Irregularities too tedious here to relate. Upon the account of all which, it has been so very hard for *Astronomers*, to reduce her Motions to Rule, and to express 'em in Numbers; and yet all these Irregularities are wonderfully accounted for, from the Action of the *Sun* and *Earth* upon her, upon the common Supposition of the Law

of

of Attraction, ev'n to a Nicety, beyond which Obſervation cannot diſtinguiſh, as is evident from Sir *Iſaac Newton*'s *Theory* of the *Moon*, which is a ſurprizing Confirmation of the Truth of that Principle. On the other hand, the Force of the *Sun*, but eſpecially of the *Moon*, diſturbs the Motion of the *Earth*, as is evident from our *Tides*, which do ſo exactly follow the Motions of the *Moon*, that he who knows the former, with ſome few collateral Circumſtances, cannot be ignorant of the latter; for when the *Moon* comes to the vertical Point of any Place, we have a *Tide* there, as alſo on the Place *diametrically* oppoſite to it; this *Tide* is greater at the *Conjunctions* and *Oppoſitions* of the *Moon* to the *Sun*, than at her *Quadratures*, and greateſt of all at the *Equinoxes*, eſpecially if the *Moon* is then in her *Perigeum*, the Reaſons of all which I have ſuggeſted in *the ſecond Chapter*. And what is here ſaid of the *Earth*, with reſpect to the *Moon*, may be with due Limitations underſtood, of any *primary Planet*, in reſpect of it's *Satellits*.

§ XVII. That the *fix'd Stars* are Bodies like our *Sun*, all the late *Aſtronomers* agree, for it's plain they ſhine by their own Light, ſince it is altogether impoſſible, that the Light of the *Sun*, ſhou'd be ſent to them, and tranſmitted to us, ſo as

to make them appear ſo lucid as we ſee them. We ſee how faintly in reſpect of ſome of the *fix'd Stars*, *Saturn* ſhines for all his Bulk; and yet his diſtance is but a Point in reſpect of the neareſt *fix'd Star*, from the *Sun*. The Rays of the *Sun* wou'd be ſo diſſipated before they reach'd ſo remote an Object, that the beſt Eye of the World, cou'd not by it, diſcover them. Their Diſtance is ſo great, that the beſt *Teleſcope*, inſtead of magnifying 'em above what they appear to the naked Eye (as they do any Object, remov'd by any menſurable Diſtance, how great ſoever) does conſiderably leſſen them, ſo that they appear like lucid Points. Beſides, tho' we in this Globe, approach nearer them ſome twenty four Thouſand *Diameters* of the Earth, (or 188304000 Miles, allowing five thouſand Feet to the Mile) one time of the Year than another, yet their *Parallax* is ſcarce ſenſible, if any at all, which cou'd not be, if they were at my moderate Diſtance: By Mr. *Hugen*'s Computation, the Diſtance of the *Sun* from us, is to the Diſtance of the neareſt *fix'd Stars* from us, as 1 to 27664, that is (allowing the Diſtance of the *Sun* from us to be 12000 *Diameters* of the Earth, and a *Diameter* to be of 7846 Miles, according to the beſt Calculations) the Diſtance of the neareſt *fix'd Star* from

us,

us, is at leaſt 2404520928000 Miles, which a Cannon Bullet moving with the Velocity it has, when parted from the Muſle of the Piece, wou'd ſpend almoſt ſeven hundred thouſand Years to go through. Since then, both theſe are true, that they ſhine by their own Light, and that they are at ſuch an immenſe Diſtance from us, it is plain, they muſt be *Bodies* like our *Sun*; which wou'd be evident, cou'd they be brought near us, or we near them, for it is only the Diſtance that creates our doubt. Now this being true, it is impoſſible they ſhou'd be all in the Surface of the ſame *Sphere*, ſince our *Sun* which is one of 'em, cannot be reduc'd to this Rule. Beſides, their different Magnitudes, ſhew that they are at as immenſe Diſtances from one another, as the neareſt of 'em is from us. Let us but imagine our ſelves remov'd at an equal Diſtance from the *Sun*, and *fix'd Stars*, we ſhould then certainly perceive no difference between them; for as to all the *Planets*, that we ſee now attend the *Sun*, we ſhou'd not have the leaſt Glimpſe of them; both becauſe their Light wou'd be too weak to affect us, and becauſe all their Orbs wou'd be united, in that one lucid point of the *Sun*. In this Station, we ſhou'd have no occaſion to imagine any Difference between one *Star* and another, but ſhou'd certainly conclude

both *Sun* and *fix'd Stars* of the same Nature; and knowing the Nature of one, we shou'd certainly conclude the same of all the rest, *viz.* that if one was a lucid Globe of liquid Fire, so wou'd all the rest be, and that they were at immense Distances from one another. If Mr. *Derham*'s Conjecture, about the appearing and disappearing Stars (of which there are many Instances observ'd by *Astronomers*) be true, to wit, that they are *Planets*, belonging to some of the neareſt *fix'd Stars*; which become visible, when they are in that part of their *Orbit*, next to our *Earth*, and disappear when they remove, to that part of their *Orbit*, which is fartheſt from us. I say were this conjecture certain, as it is not improbable, then we had a certain confirmation of the modern *Theory* of the *Celestial* Bodies; but I am afraid if the *fix'd Stars* actually had *Planets*, and they *Satellits*, that at our Distance we cou'd hardly see either. Since then there are several probable Arguments, (some of which I hinted before) that they have Attendant *Planets*, and no possible one to evict the contrary, we may safely conclude that the *fix'd Stars* are so many *Suns* in the Center of a *System* of *Planets* and their *Satellits*.

§ XVIII. Besides these already mentioned, there is another *Species* of Heavenly Bodies, call'd

call'd *Comets*, which revolve about the *Sun*; in very Oblong *Elliptick Orbits*, approaching to *Parabolick Curves*. The Times of their *Periodical* Revolutions are very long, since in three or four Thousand Years, we have not positively determin'd the Returns of above one or two; however, it's certain, that like our *Planets*, they do move in a recurring *Orbit*, that the *Sun* is in one of the *Foci* of this *Orbit*, that by a Ray from the *Sun*, they describe equal *Area*'s in equal Times, that the same *Law of Gravitation* obtains in them, which does in the *Planets*; that their *Periodical* Times are certain and invariable, and that their Motions are regular, only their Course in their *Orbits* is not determin'd one way, but indifferently some of 'em move one way, others another: They are also about the same Bulk with the *Planets*, generally speaking; and like them are compact solid Bodies, but surrounded with a vastly large thin Fluid, intermixt with several grosser Particles, and composing an irregular unequally dispos'd, and uncertainly agitated Mass; which is call'd it's *Atmosphere*, whose *Diameter*, is ten or fifteen times as long as that of it's Body. Besides which, it has a long lucid *Train*, which is rais'd in it's approach to the *Sun*, by the heat thereof, and extends sometimes to four hundred Thousand Miles above it's Body.

dy. It is always oppoſite to the *Sun*, becauſe it is the thinner part of it's *Atmoſphere*, extremely rarifyed by his Rays; and ſo rare that the *Stars* may be ſeen through it. This *Tail* accompanies it through it's Courſe over all the *Planetary Regions*, encreaſing in it's Approach to the *Sun*, and leſſening in it's Receſs. And which is very obſervable, as the *Tails* decreaſe, the *Atmoſphere* is enlarged, which happens in their *Receſs* from the *Sun*, and as the *Tails* encreaſe, the *Atmoſphere* leſſens, which happens in their *Acceſs* to the *Sun*, juſt as it ſhou'd be according to this *Theory*. Theſe *Comets* ſometimes come ſo near the *Sun*, as to be heated to ſuch a Degree that they cannot become cool again, in many Thouſands of Years. Their *Tails* are broader at their *top*, than near the Body of the *Comet*; becauſe in theſe almoſt void Spaces the Vapours are more and more rarifyed and dilated: And by this perpetual Rarefaction and Dilation, theſe Vapours of the *Tails* of *Comets*, are ſpread and diſperſed through our whole *Syſtem*: And ſo are attracted by the *Gravitation* of the *Planets*, and mixt with their *Atmoſphere*: As has been formerly ſhown; and become a ſupply of that continual decreaſe of Fluids, in the *Planets*, which is cauſed by the continual Conſumption on Vegetation, and the Putri-

Putrifaction of these Fluids. And as among the *Planets*, they are the least, which revolve in least *Orbits* and neareſt the *Sun*: So it's not unlikely these *Comets*, which in their *Aphelia*, come neareſt the *Sun*, are of the leſſer ſort: That by their *Attractions*, they may not diſturb the *Sun* too much. It is not improbable, that ſome of theſe *Comets*, have viſited our *planetary Regions* oftner than once. The *Comet* that appeared in 1667, and that in 1682 had both, by computation, pretty near the ſame *Orbit*, the ſame *Aphelia*, and *Perihelia*, and the ſame Inclination of the *Plane*, of their *Orbits* to the *Plane* of the Ecliptick: And conſequently, it's not improbable, that they were both one and the ſame *Comet*. And therefore the time of it's Revolution, is about 75 Years. The reſt of the *Comets*, take up a longer time, in their Revolutions; and aſcend higher from our *Syſtem*. Beſides the *Comets* by reaſon of their great Number, the great diſtance of their *Aphelia*, from the *Sun*, and conſequently their long ſtay and ſlow Motion in theſe *Aphelia*; muſt diſturb one another, by their mutual *Gravitations*: And therefore their *Eccentricities*, and the times of their Revolutions, muſt ſometimes be encreaſed and ſometimes leſſened: And conſequently, it is not to be expected they ſhou'd conſtantly return in the ſame *Orbits*,

and

and in the same *Periodical* times exactly: It's enough, the changes be not greater than may be expected from such Causes; and from hence we may observe, the reason why the *Comets* are not contain'd in the *Zodiac*, as the *Planets* are: But direct their Courses differently, on all Hands, and through all the Regions of the Heavens; and that is, that in their *Aphelia*, where they move the slowest, they may be at the greatest distances from one another: And so *attract* and disturb one another the least that may be. The *Comet* that appeared in 1680, approached the *Sun* nearer than a sixth part of his *Diameter*, and by reason of that *Comets* great Velocity, at so near a distance, and the somewhat Density of the *Sun*'s *Atmosphere*. It must have suffered some resistance to it's Motion thereby, and so must have been somewhat retarded, and must have approach'd somewhat nearer the *Sun*, so that in every Revolution, approaching nearer and nearer the *Sun*, this *Comet* must at last drop into the *Sun*'s Body; as also this *Comet* may in his *Aphelium*, where he moves the slowest, be retarded by the *Attraction* of other *Comets*; and thereby in his return, be swallow'd up of the *Sun*. After the same manner, the *fix'd Stars*, which by little and little expire in Light and Vapours and so are extinguished, may be re-

kindled

kindled by *Comets* falling into them, and being recruited by this new Fewel be accounted *new Stars*. If they be not *Planets*, accompanying the neareſt *fix'd Stars*, as Mr. *Derham* conjectures.

§ XIX. Thus I have given a ſhort View of this *Syſtem* of things, as it is at preſent, and I am of Opinion it is nearer the Truth than the *antient Theories*. And now let any one ſeriouſly reflect upon the *Vaſtneſs*, *Magnificence*, *Beauty*, *Order*, and *Symmetry* of this *Scheme*, and try if he can think it the Effect of Chance, or, if he can ſo much as doubt, that ſome infinitely wiſe and powerful *Architect* has rear'd this noble *Fabrick*. But to drive the Argument farther, let us enquire a little into the particular and obvious *Deſigns* and *Contrivances* of this Divine *Architecture*. And 1. It is plain from what has been ſhewn, that the univerſal Principle of *Attraction* or *Gravitation* obtains in all the Great Bodies of this Univerſe; and that the Motions of all the *Planets*, their *Satellits* and the *Comets*, are govern'd by one Condition thereof, *viz.* that the Force thereof at different diſtances from the Center of Attraction, is *reciprocally* as the *Squares* of theſe Diſtances. Now is it at all probable that ſo *univerſal a Law*, ſo powerful a *Principle*, and ſo conſtant a Rule ſhou'd be owing to Chance? If one with 10000 Dice,

ſhou'd

ſhou'd throw 5000 Sizes, once or twice, or even 1000 Sizes once and again, we might poſſibly ſay he did it by Chance; but if with an almoſt infinite Number of Dice, he ſhou'd always without failing throw the ſame ſide in 'em all, we ſhou'd certainly conclude, he either did it by *Art* and *Contrivance*, or that theſe Dice cou'd turn up on no other ſide. Now I have demonſtrated that *Gravitation* is not *eſſential* to Matter, and ſo it might have been without it; and yet all the Bodies of the Univerſe, ſo far as we can diſcover, are endow'd with this Principle; and obſerve this one Condition of it, and therefore, both were deſign'd by him who laid the Foundations of the World. 2. It is worth our Obſervation to take Notice, how conſtant and beautiful a Proportion, the Times of the Revolutions of all the *Planets*, and their *Satellits*, keep to their *middle Diſtances*; for univerſally, in all the Revolutions of the *Planets* about the *Sun*, and of the ſecondary *Planets* about the *primary* ones, the *periodical Times* is in a *Seſquialter* Proportion to the *middle Diſtances*; or the *Cubes* of the middle Diſtances, from the Center of their Motions, are in all of them (*Planets* and *Satellits*) as the *Squares* of the *periodical Revolutions*. 3. All the *Planets* and *Comets* by Rays from the *Sun*, and all the

the *Satellits*, by Rays from their primary *Planets*, deſcribe equal *Area*'s in equal Times, *i. e.* the *Area*'s deſcrib'd, are always *proportional* to the Times pretty nearly. So that when they approach to the Center of their Motion, they move faſter, and when they recede from it, ſlower; ſo as to compenſat their nearneſs, by their Swiftneſs, and their Diſtance by their Slowneſs: Always making up equal *Area*'s in equal Times. Theſe two ſo *univerſal*, and ſo *regular* Affections, of the Motions of the *Celeſtial* Bodies, are not only diſcoverable by Obſervation, but are the neceſſary Effect, of the Law of Gravitation, juſt now mentioned to be the *Principle* of the Heavenly Motions. Can any Body now, who conſiders how many things are concurring to, and depending upon theſe beautiful *Proportions*, and regular Effects, ſo much as once queſtion whether they are the Product of infinite Wiſdom? Certainly nothing leſs cou'd be ſufficient, to make the *Computation*, adjuſt the *Forces*, and determine the *Powers*, neceſſary towards the Production, of ſuch exact and regular *Effects*. 4. All the *Planets* are ſo wiſely ſituated, in reſpect of the *Sun*, that the denſer *Planet*, is ſtill neareſt him, and the leſs Denſe, is fartheſt remov'd from him; and the leaſt Denſe of all, is the moſt remote. Now can any Body think this

was

was so ordered without *Design*? No certainly, it is so obvious no Body can miss of it; for it is plain the more Dense Matter requires a greater Degree of Heat, to fit it for natural Productions; and the less Dense, needs only a lesser Degree of Heat, for the same End. And consequently, their Distances were adjusted for this very Reason; and this by the by, is a Presumption for the *Planets* being inhabited, since according to their Densities, they are fitted with Degrees of Heat necessary for natural Productions: Now this Adjustment and these natural Productions were useless, if there were no Creatures to enjoy the Benefit of 'em; and we all know Nature has done nothing in vain. And therefore since these *Accommodations* are provided for living Creatures, there are such probably to enjoy 'em. 5. The *Velocity* of the *Planets* Motions, is so adjusted in respect of the *Sun*, and the *Velocity* of the *Satellits*, in respect of their *primary Planets*, that the *Planet* which is neareſt the *Sun*, moves fastest, and those more remote, less fast, and the farthest, slowest of all. And so in the *Satellits*; the neareſt to the *primary Planets*, moves quickest, and the remotest, slowest. For since the *Centripetal* Forces, are *reciprocally*, as the *Squares* of the *Distances* from the Center, and the *Celerities*

*lerities* in that caſe, reciprocally, as the *ſquare Roots* of the Diſtances from the Center; and ſince the ſquare Root of the remoter Diſtance is greater, than the ſquare Root of the nearer, therefore the Velocity of the nearer, is greater than that of the remoter. Now this is a wiſe *Contrivance* of the *Author* of *Nature*; for ſince the nearer *Planet* enjoys more of the Heat of the *Sun*, than the remoter, it was fit the Viciſſitudes of the Seaſons, ſhou'd be quicker, that anſwering beſt the Ends of natural Productions; for ſince their Diſtances are leaſt, and their Velocities greateſt, that are next the *Sun*, their *Periods* muſt be ſhorteſt; and ſince they all move about their *Axes*, moſt, if not all of them, making thereby ſome *Angle* or other with the Plane of their *Orbit*, they muſt admit of variety of Seaſons; and where the Heat is greateſt, there for the conveniency of natural Production, it was neceſſary the Seaſons ſhou'd be ſhorteſt, where the Heat is leaſt, there the Seaſons ſhou'd be longeſt: Now all theſe Effects are taken care of by this adjuſting of the Velocity to the Diſtance. And what is here ſaid of the Seaſons in reſpect of the *Planets*, may be underſtood of the *Satellits* Influences, from their *primary Planets*; for whatever Effects the *primary Planets* produce on the *ſecondary* ones, it is doubtleſs moſt

convenient, the Vicissitudes thereof shou'd be quickest, in the neareſt, and slowest in the remotest *Satellits*. And this, as well as the former, is a shrew'd Presumption of the *Planets* being inhabited; for all this beautiful Contrivance is lost, if there be no Inhabitant in the *Celestial* Bodies to enjoy the Benefit of it. 6. All the *Planets*, describe about the *Sun* in one of their *Foci*, *Elliptick Orbits* of one Species or another; and all the *Satellits* describe about their *primary Planets* in one of their *Foci*, *Elliptick Orbits* also; and the Planes of all the Orbits do very nearly coincide with one another, and with the Plane of the *Ecliptick*. That the *Planets* describe *Elliptick Orbits* about the *Sun*, there is no manner of doubt now among *Astronomers*. And tho' they say, that the *Orbits* of the *Satellits* are not exactly *Elliptical*, yet that is from necessary Causes, and is not owing to Chance, but to the already establish'd Laws of the Universe; yet still their *Orbits* are nearer *Ellipses* than any other *Geometrical Curves*, and may be reduc'd to these; and that the Planes of the *Orbits* of the *Planets* coincide with the Plane of the *Ecliptick*, and with one another nearly, is matter of Observation. Now is it imaginable, this beautiful and constant Order of these three things, of *Elliptick Orbits*, the Situation of the *Sun*

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in the one of the *Foci*, and the Coincidence of the Planes, of the *Orbits*, with that of the *Ecliptick*, cou'd have been the Effect of Chance and Casualty? Or that it was without Design or Counsel? No certainly, for the Advantages thereby arising to our *Earth* in particular, are evident; for thereby, the colder and more Northern Places of our Globe, are brought some hundreds of thousand Miles, nearer the *Sun* in Winter than in Summer; which cannot but be of some small use to those Places, that by the natural Course of the Earth, are depriv'd of the benign Influence of the *Sun* at that Season. Now this Benefit wou'd be constant if the Place of the *Perihelium* did not change; but since that is not constant, the other is not durable, but temporary. But this change is not now to be taken notice of, since it is a Question if these Irregularities were any part of the first Contrivance of this Universe. Now tho' in the rest of the *Planets*, the Situation of their *Perihelia*, is not the same; yet nothing is to be concluded from thence, against this Argument, since we know not the Nature of their Inhabitants, nor of their natural Productions: But this we may conclude, since it is of notable Use to one of the *Planets*, it cannot be amiss to any of 'em, they agreeing in most things: But what-

ever be the Design thereof, yet the constant Order of these things are a sufficient Proof that they were not Casual, but the Work of infinite Wisdom. 7. The *Sun*, all the *Planets*, and their *Satellits*, so far as we have had occasion to know, move about their own *Axes*, the *Axe* of this Rotation is always *parallel* to itself, and they revolve all one way from West to East, and that in Planes, almost coincident with one another, and that of the *Ecliptick*. As to the *Rotation* about their own *Axe*, it is matter of Observation in the *Sun*, the *Earth*, *Mars*, *Jupiter*, *Venus*, the *Moon*, and it is very probable in the other two; and as to the *Parallelism* of the *Axe* of their Rotation, it is demonstrable *à priori*, as I have formerly shewn, and wou'd be nicely exact, if the same were not disturb'd by some collateral Causes; as also the Coincidence of the Planes of this Rotation, with one another, and with the Plane of the *Ecliptick*, is so very near the Truth, that the small Difference from it, is not to be regarded. Now can these constant and regular Effects be ascrib'd to any thing, but an over-ruling Providence? Can Jumble, and Confusion produce regular and invariable Effects? It is altogether impossible, and therefore, nothing but the Author of Light, and Order, and Beauty, cou'd have brought about

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ſo uniform, and ſuch conſtant Effects. Farther, let us now conſider, that all theſe beautiful and comely *Proportions*, all theſe conſtant and immutable *Effects*, all theſe uniform and regular Appearances, which agree, not to a few things, or in ſome particulars, but in moſt of them, to all the *Planets*, to all their *Satellits*, to the *Sun*, and the *Moon*, and the *Comets*, and in a Word, to every thing in this our *Syſtem*, might have been varied, ſeveral and diverſe ways; and yet none of 'em wou'd have fitted ſo well, to the preſent ſtate of things, and the univerſal Benefit of the whole *Syſtem*, as theſe already ſettled. Thus there might have been an *infinity* of different, poſſible Laws of *Gravitation*, yet none of them wou'd have fitted our preſent Circumſtances, ſo well as the *Reciprocal Duplicat*. There are innumerable *proportions*, beſides the *Seſquialter*, yet none of 'em had ſuited us ſo well, becauſe this is the Effect of the Law of Gravitation, and on theſe two, all the ſubſequent Advantages from the preſent eſtabliſh'd Motions of the *Planets* depending, any other different from theſe wou'd have depriv'd us of thoſe Advantages. The various poſſible Diſtances of the *Planets* from the *Sun*, the poſſible Times of their *Revolutions*, their poſſible *Celerities*, the poſſible *Figures* of their *Orbits*, and of the *Inclinations* of their

Planes to one another, and to the Plane of the *Ecliptick*, their possible *Densities* and *Bulks*, and the possible *Changes* of their many other *Affections*, are in number infinite; and yet I have shewn that most of these as they are at present, bring very considerable Advantages with them, to the *System* in general, which consequently wou'd be lost, were they dispos'd after another manner. Add to these, that all these Affections of the *Heavenly Bodies*, might have been in no regular Order, nor constant Proportion, at all, and consequently the possible Varieties of the *Celestial Bodies* might have been infinite among themselves, and different from those now mentioned. But seeing every thing is adjusted by *Number*, *Weight*, and *Measure*, seeing they observe *Order* and *Proportion*, and that every one of 'em is dispos'd in the fittest *Order*, the present state of things will admit, since both the whole and the several Parts of the *Celestial Fabrick*, is both very good, useful, and convenient, who that considers all these things, dares so much as doubt whether he who did all these things *lives and reigns for ever and ever?* Or who can forbear to admire and adore him, who *weigh'd the Mountains in Scales, and the Hills in a Balance, who stretch'd the Heavens like a Curtain*, and held the Earth in his Hands, *whose right hand*,

*hand*, and *ſtrong Arm does wonderful things paſt finding out.*

§ XX. Having now conſidered, ſome of the more general Affections, of the *Heavenly Bodies*, and of their Motions, and ſhewn ſome of the Advantages, ariſing from their preſent Order and Diſpoſition. I come now to conſider the *Celeſtial Bodies* a little more particularly, and firſt as to the *fix'd Stars*, can any thing beget a greater *Idea* of the Univerſe, or of it's Creator, than that *prodigious* number of glorious Bodies, like our *Sun*, rang'd all up and down the *immenſe Vaſt*, and remov'd at Diſtances from one another anſwerable to their Diſtance from us? This, not only their different *apparent Magnitudes*, but likewiſe the number of thoſe of the firſt, and ſecond Rate, does evince. For upon the Suppoſition, that every *fix'd Star*, is like our *Sun*, and governs in a Portion of *Mundan ſpace*, equal to our *Syſtem*, then there muſt be only as many *fix'd Stars* of the firſt Magnitude, as there are *Syſtems* that can ſtand round ours; but there are but about twelve or thirteen *Spheres*, that can ſtand round a middle one, equal to 'em; and ſo many are the *Stars* of the firſt Magnitude. Again, if we examine how many *Spheres* can ſtand round this firſt Range of *Spheres* we will find their number betwixt forty eight and fifty two, and

ſo we find the number of the *Stars* of the ſecond Magnitude. As for the ſeveral other Magnitudes, it is not altogether poſſible to determine their number, becauſe they are not ſo diſtinguiſhable from thoſe of the other Magnitudes, as the firſt and ſecond are. Beſides, I do not plead here for Accuracy, but only for things being nearly ſo; for, I do not think that the *fix'd Stars*, are either all of the ſame real Magnitude, or that their *Syſtems*, are all of the ſame Dimenſions: Theſe things being nearer any regular Proportion, than they are to Irregularity, is ſufficient for my Purpoſe; for it is impoſſible for any Body, ſeriouſly to conſider in his Mind, or view with his Eyes, what is certain about theſe glorious Bodies, to hinder himſelf from being raviſh'd with the Power and Wiſdom of the *Great God of Heaven and Earth.*

§ XXI. How *beautiful* and *glorious* a Body is the *Sun*, and of what abſolute Neceſſity to the Being of all *Animals* and *Vegetables!* As to *Vegetables*, it is beyond all doubt, that without him they cou'd never riſe above the Ground; for it is his Heat alone, that rarifies the ſizy vegetable Juices about their tender Roots, and makes them force their way, to diſplay all the Foldings of the ſlender Seed, and thereby to augment their Parts; juſt as we find his Heat,

Heat, raiſes the Liquor in the *Thermometrical* Tubes, and drives them through all it's winding Branches, and tho' perhaps *Animals*, might make a ſorry Shift (ſuppoſing Food cou'd be ſupply'd 'em without his Influence) in a perpetual State of Darkneſs, yet it wou'd be a very miſerable ſort of Life, and cou'd be of no long continuance; for we know, how neceſſary the *Sun* is to purify our Air, and to exhale the *noxious* Dews, and the baleful Vapours of the Night; we feel a ſenſible Joy in his Light, and Heavineſs in his Abſence; foul Weather, and a cloudy Day, is a Diſeaſe alone, and he who underſtands the *Animal Oeconomy*, knows the Reaſons, and the *Mechanical* Neceſſity of all theſe things, One thing ev'ry Body knows, *viz.* that by the Heat of the *Sun*, and the Action of his Rays, the Circulation is promoted and that infinite Number of the *excretory Ducts* of Perſpiration, plac'd along all the ſuperficial Parts of the Body are open'd, and enlarg'd, and ſo thoſe Exhalations, which Nature has deſign'd ſhou'd be carry'd out of the Body, are more freely and plentifully deriv'd; which muſt needs give a greater Freedom to the Blood and Spirits, the contrary of all which, happens in the Abſence of this *Benign Star*. But of this more afterwards. It's being ſituated immoveable in

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the Center of our *System*, no Body who has been at the pains to consider the Matter, I believe doubts now, for not to mention at present the Controversy about the *Parallax* of some of the *fix'd Stars*, which Mr. *Flamsted* has observ'd, and whereby he pretends to demonstrate the Motion of the Earth, and consequently the Stability of the *Sun*; there are some other Arguments that will have sufficient Weight to settle the Matter among thoughtful Men. For 1. It is altogether impossible to account for the Appearances of the *Planets*, their *Satellits*, and of the *fix'd Stars*, in any tolerable manner, without admitting the Motion of the Earth. 2. It is likewise impossible to account for the Motions of the *Comets*, upon any other Supposition. And 3. that Analogy of the *Periodical* Times, to the *middle Distances*, which is the necessary Consequence of the establish'd Law of Gravitation, does demonstrate the Earth's Motion *a priori*; so that unless we wou'd subvert the whole *System* of *Astronomy*, and disprove the Causes of all the Celestial Motions, we shall never be able to prove the Stability of the *Earth*. For if the Celestial Bodies attract one another in a *duplicate Proportion reciprocally*, to their Distances from the Center of their Revolutions, then the *Earth* (and not the *Sun*) moves. Add to all these, that there

there is no tolerable Objection againſt the Earth's Motion, but has had a full Anſwer, and a plain Solution. Now what an Inſtance of Wiſdom and Contrivance is this, in placing that Fountain of Light and Life, in the Center of his *Syſtem*. How unartful wou'd it have been, to have ſet him in a Corner, when he was to have giv'n Light and Warmth to all the Bodies round him; beſides, to the conſervation of any ſuch Suppoſition (ſuch as the *Tychonick* or *Ptolomiack*) there are requir'd ſo many different Laws of *Gravitation*, that any reaſonable Perſon by inquiring into them, wou'd eaſily diſcover, that whatſoever was Matter of Fact, yet this Poſition of ours was the moſt ſimple and eaſy, and look'd moſt like the Effects of Wiſdom and Deſign: For here one ſingle Law, accounts for all the various Motions and Appearances of the *Celeſtial Bodies*. Thus then this great and glorious Body is fix'd, like a powerful and a kindly *Monarch* on his Throne, diſtributing Light, Warmth, and Life in plentiful Effuſion, to all his ſurrounding *Vaſſals*, and that ſo equally, that the neareſt have not too much, nor the remoteſt too little. Theſe are ſuch great, ſuch wiſe Ends, as clearly ſpeak the *Omnipotence* and *Omniſcience* of their *Author*. Moreover, let us conſider, with how much Artfulneſs his Bulk

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and Situation, in respect of the *Planets*, is contriv'd, to have just Quantity enough of Matter to draw round him these Massy Bodies, and their *Satellits*, so various in their Bulks and Distances from him; and that in regular and uniform *Orbits*. How exactly his Body is rounded, how fully it has been saturated with the Fluid of Light, to be able to last so many Years without any sensible Diminution, tho' there are constant Emanations thereof upon his Attendents. As for his *Rotation* about his own *Axe*, it is no doubt likewise, for wise Ends and Purposes, perhaps it may be for the better propagating, and emitting this Fluid of Light, through the *Planetary Regions*, or for helping forward the Revolutions of the Planets in their Orbits round about him.

§ XXII. We can no otherwise gather the usefulness of the *secondary Planets*, to their *primary* ones, but by supposing the rest may reap *respectively*, some thing *analogous*, to the Benefits we of the Earth, receives from our *Moon*, which are 1. The supplying of the *Sun* in the Night time, for at least three fourths of the Year. Now how comfortable and delightful a thing this is, Travellers and Voyagers can best tell, *Curiosity*, *Ambition*, and *Luxury*, if not sometimes *Necessity*, have now made it unavoidable, that some part of Mankind shou'd be travel-

travelling by Land or Sea, in the Night Seasons; how pleasant then, and joyful a thing, is it to have a Light held us forth from *Heaven*, not only to guide our Steps, but to direct us in our Course, and to point out to us, how our time wears out? For a very little Experience, makes us reap both these last Advantages from the Presence and Motion of the *Moon*. 2. She raises our *Tides*, twice in twenty four Hours, which how absolutely necessary that is toward the subsistance of *Animals* and *Vegetables*, we shall now shew. Every Body knows that a *Lake* or *Loch*, that has no fresh Water running into it, will by the heat of a few Months, and it's Stagnation, turn into a stinking rotten *Puddle*, sending forth nauseous and poysonous Steams; for tho' I do not think, the constituent Particles of Water themselves, are alter'd by this Stagnation, yet no Water is absolutely pure, but contains a greater Quantity of Fleshy, Bony, Earthy, Salin, Metallick, and Vegetable Particles, than of pure *Element*; and it is upon these, the heat operates, by dissolving their Union, and combining them in new Forms, and separating these *Salin*, *Sulphurous*, and other *noxious* Particles which produce this Effect. Now tho' there be many thousands of fresh Water Rivers, daily running into the *Sea*, yet they are very incon-

inconsiderable in respect of the *vast Ocean* of Salt Water, and wou'd by no means hinder it's Stagnation, and consequently it's Corruption and Stinking. But admit the Ocean once stagnated, and then the first Effect wou'd be, that all the Places toward the Shores, wou'd be first wrought upon by the Action of the *Sun*, and turn'd to a *Memphitis*, and then by Degrees it wou'd get farther, till the whole were become more *baneful* and *poysonous* than the Lake of *Sodom* and *Gomorrah*; whereby the *Fishes* wou'd be first destroy'd, and by the noxious Steams thence arising, afterwards the *Plants* and *Animals*; whereas by this Action of the *Moon*, the Waters are lifted up in a heap, as it were, and then let fall again; whereby the Waters near the Shores, are constantly secur'd from Stagnation and Corruption, and the beginning Malady stifled. This perpetual Change of new Water on the Shores, keeping any one Portion thereof, too short a time, expos'd to the heat of the *Sun*, to have it's mixture corrupted. Now what a *noble* Contrivance have we here! by appointing an *Attendant* to our *Earth*, all the *Vegetables* and *Animals* are preserv'd from certain Destruction; (but I am of opinion that to the full effect of this wise Design, the Salt of the Sea does very much contribute; for as I have said before, and

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may obſerve afterward, the pointed ſlender Particles of the *Salt*, ſtick the Parts of Bodies ſo together, that the Particles of Heat, cannot ſo eaſily tear 'em aſunder, and it is *Fact*, and *Obſervation*, that there are many ſalin Rocks and Mountains diſperſed over the Foundations, of the Great *Ocean*.) Beſides this, how many Conveniencies for our *Navigation*, in Rivers and Harbours, does this ebbing and flowing of the *Sea* afford? No Body that conſiders them, can ceaſe from Wonder, or can continue in Unbelief. And here perhaps it will not be amiſs to conſider, that if our *Earth* had any more than one *Moon* attending it, that we ſhou'd receive more Damage than Advantage from it; for tho' perhaps thereby our Light in the Night (provided ſhe were of any Bulk, or at any Diſtance near to that of our preſent *Moon*) might be augmented, yet at the *Conjunctions* and *Oppoſitions* with one another, and with the *Sun*, we ſhou'd have Tides that wou'd raiſe the Waters over too much of our dry Land, and in their *Quadratures*, we ſhou'd have no Tide at all. In ſhort, if our *Moon* were bigger or nearer the *Earth*, or if we had more than one, at any tolerable diſtance from us, we ſhou'd be every now and then, in hazard of being drown'd; and if our preſent *Moon* were leſs, or at a greater diſtance, or if there were none at all,

all, we ſhou'd be in hazard of being ſtifled by the noxious Steams ariſing from the *Ocean*, which wou'd ſtagnate more than it now does. From all which it's evident how wiſely our *Satellit*, has been contriv'd for our Purpoſes. As for the numerous Attendants of *Jupiter* and *Saturn*, they muſt be reaſonably expected to fit the Neceſſities of the Inhabitants of theſe *Planets*, ſince our Moon ſuits us ſo well. As to *Jupiter*, conſidering his Bulk and Diſtance from the *Sun*, being near 400 times bigger than our *Earth*, and receiving but a twenty fifth Part of our Heat: In what a diſmal State of Cold and Darkneſs eſpecially, wou'd he be in? Were it not for his *Moons* or *Satellits*, and for his Rotation about his *Axe*, in about *Ten Hours*: Whereby the little Vigor of his Light and Heat is compenſated, by its quick Returns. His *Satellits* being each of them as big as our *Earth*, and reflecting in upon *Him* ſo ſtrong, briſk, and vivid a Light, as they do: And their *Revolutions* being ſo adjuſted, as may be ſeen, in the *Table of them in the beginning of this Chapter*: It thereby happens, that ſcarce any Part of this *Planet* is any time without the preſence and influence of ſome one or more of theſe *friendly Attendants*. So that by this numerous Retinue, their ſtrong Light, the encreaſing *Periods* of their Revolutions, as they are

diſtant

distant from him, and his quick Motion about his *Axe*: His Light and Heat are wonderfully encreas'd, from what they wou'd be without these Contrivances and Adjustments. But that which is the finest Contrivance of all, in these *Satellits* is (as Mr. *Derham* has observed,) in their Latitudes, or their Evagation towards *Jupiter*'s Poles, the Latitude of the innermost being $\frac{1}{3}$ of *Jupiter*'s *Diameter*, of the next $\frac{1}{2}$, the third $\frac{3}{4}$ and the last going beyond *Jupiter*'s *Poles*, one third part of his *Diameter*: And as their *Latitudes* differ according to their Distances, and Periods, so they change their *Latitudes* in shorter or longer times according to their lesser or greater *Latitudes*, some making their Progress towards his *Poles* one way, whilst some are wandering the other, some staying there a longer time, and some a lesser and a lesser time, by which quadruple variety, those large Tracts towards the polar parts of this huge *Planet*, have a constant and yet various share in the Light and kindly Influences of these four *Moons*, and are scarce ever depriv'd of one or other of them. As to *Saturn* as he is yet farther from the *Sun*, than *Jupiter*, and has but the hundredth part of our Heat, he is accordingly provided with more *Satellits* (at least five if not more,) adjusted much after the same manner, and appointed for the

same ends and purposes with those of *Jupiter*, we have now describ'd. But he has still a further provision made for *him*, and that is his *Ring* the most surprizing and singular Appearance in all the *Celestial* Regions: It's size is prodigious, being more than twice as broad in *Diameter*, than *Saturn* is: And the breadth of the *Ring* it self about a fourth part of *Saturn*'s *Diameter*: And *it's* distance from *his* Body about the same length, whereby the *Sun*'s Heat and Light has a free admittance between the *Planet* and its *Ring*, while other Heat and Light is at the same time reflected in upon it, by this *Ring*. Its thickness is scarce perceiveable, which prevents its throwing any great Shadow on *Saturn*. But its smoothness and reflecting faculty, is very considerable, as is evident from the exceeding Brightness and Illustration it reverberates on its *Planet*: So that it seems not unlikely, that it may be a kind of *Specular* Contrivance, for reflecting Heat and Light on its central Sovereign, in his great distance from the source of Light and Heat. And very probably *Saturn*'s Period, on his *Axe*, or diurnal Rotation, may be pretty quick, and his Inclination to the Plane of his *Ring*, or Plane of his *Orbit* pretty large, as it is in *Jupiter*, to make all these wise Provisions and Accommodation perfect and compleat. But further we may observe one

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very ſignal Inſtance of *Wiſdom* and *Contrivance*, in placing the Heavenly Bodies at ſuch a Diſtance from each other, and eſpecially the greateſt at the greateſt Diſtance; for had they been ſituated much nearer to one another, they wou'd have caus'd prodigious Diſorders in very different Manners, and in particular ſuch deſtructive *Tides*, wherever there was any Quantity of Fluids, or great *Oceans*, that neither *Animals* nor *Vegetables* wou'd have been able to ſuſtain their Fury; which by this prudent placing the *Heavenly Bodies*, at ſuch a Diſtance from one another, are intirely prevented. 3. From our *Moon* the *Eclipſes* call'd by her Name proceed, which is of exceeding uſe in *Navigation*; for by them the Differences of *Meridians*, and the *Longitudes* of Places are determin'd. Of the ſame uſe are the *Eclipſes* of the *Sun*, and of the *Satellits* of the other *Planets*; which laſt being ſo frequent, are of wonderful Aſſiſtance, toward the Solution of this ſo deſirable and ſo much deſiderated *Problem*. And upon this Head of *Navigation* all *Aſtronomy* comes in, without which the other were meer groping in the Dark; but the World is already ſo ſenſible of the Advantages ariſing from the Motions and Appearances of the *Heavenly Bodies*, in the Matter of *Navigation*, that I ſhall inſiſt no farther on this

*Topick*, neither shall I mention, the probable Influence the *Moon* has on *Vegetables*, *irrational* or *rational Animals*: The last having been fully canvass'd, in that *curious Treatise* of the *Accurate* and *Learned* Dr. *Mead* in his Book *de Imperio Solis & Lunæ in Corpora Humana*, but from this whole Section about the use of the *Attendants* of the *Planets* shall infer, that they are not mute Persons, in this great *Drama* of the World, but loudly proclaim the *Wisdom* and *Being* of their *Author*.

§ XXIII. As to the *Comets*, I have little more to say about them, than what I have already said, their *Natures*, *Orbits*, *Motions*, and *Situations*, have been so lately determin'd, (indeed it is but of late, that the *Astronomy* of the *Planets* themselves, and their *Satellits* has been brought to any tolerable Perfection, and much later since final Causes have been cultivated, with Care becoming so noble and useful a Part of *Philosophy*;) and there are so few accurate Observations about 'em extant, so few of 'em, that we know of, have visited us twice, that we have scarce any solid Foundation to build our Reasoning upon, all I think can be rely'd on is, that they are solid Bodies like our *Planets*, that like them they move in regular very oblong *Elliptick* Orbits, in one of whose Centers or *Foci* the *Sun* is placed.

placed. That they do revolve by the ſame Virtue of *Gravity*, and by the ſame Law thereof, as theſe do. That their *Train* is raiſed by the Heat of the *Sun* as they deſcend toward him in their *Perihelium*, ſeeing it encreaſes in it's deſcent towards the *Sun*, and leſſens in its aſcent from him. That this *Train* is only the more Fluid part of its *Atmoſphere* extremely rarifyed. That ſome one or more have return'd in the ſame Orbits and with the other determining Circumſtances, pretty nearly, whereby it is render'd probable that theſe were one and the ſame, only in different Revolutions. And if the uſes aſſign'd to them by Sir *Iſaac Newton* be real, as they are not improbable, to wit, the ſupplying the Deficiency and Expences of all the ſorts of Fluids neceſſary or uſeful to our *Syſtem* in general, and to our *Globe* in particular. I mean not only Light and Heat to the *Sun* and *fix'd Stars*, Water and watery Vapours, to our *Atmoſphere*, but the moſt ſubtile, moſt uſeful, and neceſſary part (towards Life and Vegetation) of our Air to that *Elaſtick* Fluid. And very probable, other Advantages *Analogous* to theſe they bring to our *Earth*, and ſuited to their particular Wants, to the other *Planets* and their *Satellits*. If, I ſay, theſe uſes aſſign'd to them, and juſtly riſing from their Natures, and the known *Analogy* of Things,

be real, then these wandring frightful Bodies may be justly concluded joyning in the *Chorus* and loudly resounding the same *Allelujah.*

§ XXIV. Come we now to enquire into the Wisdom of the Contrivance of the *Planets.* But having already shewn the *Analogy* between them and our *Earth*, and how probable it is that they are inhabited by Creatures fitted for such Habitations, I shall content my self with pointing out some of the most considerable Instances of *Design* and *Wisdom* in this our *Planet*; hoping the Reader will reason after the same manner (bating particular Circumstances) of the rest, and that, both because the design'd Brevity of this Treatise will not permit me to be so particular, as the Subject deserves, and because, if the *Analogy* hold in general, the particular ones (with allowance for Circumstances) will easily follow. And first let us consider the Advantages, arising to us by the *Rotation* of the *Earth* about its own *Axis.* We the Inhabitants of this Globe are so made, that once in sixteen or twenty Hours at most, we require a time for *Relaxation*, and generally speaking, in all healthful People this time is pretty equal, between six and nine Hours, the Store-houses of our Spirits will not permit any longer Application than twenty Hours, without Injury

jury to our Conſtitutions, and much about the time of ſix Hours is requir'd to fill 'em again; and generally ſpeaking, it is neceſſary that an Alternation of *Application* and *Relaxation*, ſhou'd be once in twenty four Hours. It's true Cuſtom and Education, may get the better of theſe *natural Propenſities*, and a very ſtrong Conſtitution may bear out with harder Meaſures for ſome time; but the Young, and the Weak, and almoſt all at their own Liberty, naturally run into a *Relaxation*, and recruiting their Spirit by Sleep, once in twenty four Hours. It was likewiſe neceſſary, that the Air ſhou'd be at leaſt cool and temperate, during the time of this Reſt, for we generally find thoſe that ſleep in the open Air, or ev'n while the *Sun* is above the *Horizon*, the worſe for it; the *Sun* and Heat exhaling the natural Perſpirations too violently, while they are crude (hence it comes that People generally Sweat moſt who Sleep in the day time) and raiſing too quick a Motion, in the Blood, whereby the Sleep is leſs calm, and more diſturb'd. And tho' we generally perſpire more in the Night than the Day, yet the Perſpiration is leſs crude, more natural, and leſs violent, and more according to the Neceſſities of our Conſtitution, in the Night than the Day. Beſides, that of neceſſity, the Darkneſs is leſs ſubject to Noiſe

and Diſturbance, than the Day. Now all theſe things are wonderfully provided for by the *Rotation* of the *Earth* about its *Axis*; for thereby we have the *Viciſſitudes* of Day and Night, the Day for *Application* and ſpending our Spirits in about the neceſſities of Life, the Night by its Coldneſs and Quiet, to afford us time to recruit 'em, and lay up in ſtore, for the Expences of the next Day; as alſo for nouriſhing the Muſcles, Bones, Channels, and the other Parts of the Body; for the Buſineſs of Nutrition is moſtly, if not altogether perform'd in the time of Reſt, becauſe the Blood has too rapid and quick a Motion, the Expences of the Spirits are too great, to afford Leiſure, or Materials for nouriſhing the Parts in the time of Application: Beſides that a gentle uniform Motion is requir'd to apply nouriſhing Parts, to the neceſſary Places, and to ſettle 'em there; and we generally find that People recovering from a Diſeaſe, and Children, ſleep more, and are more fed by their Sleep, than by any other *Animal Function*, and groſs People naturally Sleep longeſt. Likewiſe, what a comfortable and refreſhing thing is the cool Breezes of the Night, the *Trade-winds*, to thoſe that live under the *equatorial Parts*, without which Life wou'd be both exceeding ſhort, and very grievous. As to theſe *Trade-winds*, they

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are the neceſſary effect of the *Rotation* of the *Earth* about its *Axe*, which under the *Line* makes the Rays of the Sun direct and equal all the Year round, ſo that theſe parts being conſtantly under the *Sun*'s Influence, his Heat rarifies one part of the Air, and the cooler and heavier part preſſes upon the hotter, and ſo makes a continual Wind in his Courſe from *Eaſt* to *Weſt* under the *Tropicks*, which is both of great uſe in *Navigation*, and of great Comfort to the Inhabitants of that ſcorched Climate. Moreover, let us reflect upon the Neceſſities of our *Vegetables*, which are the ſupport of Animals; we have before ſaid, that the Heat of the *Sun* rarifies, and conſequently raiſes the ſizy vegetable Juices, at the Roots of the tender Seeds, and thereby forces the folded Branches to expand and enlarge. Now were the *Sun* conſtantly, or for any long time, ſhining upon them; theſe Juices wou'd not be at liberty to ſettle, and conſolidate in the fit Places of the Branches; but wou'd be ſtill riſing higher and higher, till at laſt they burſt the Canals, (if Vegetable Fluids were conſtantly ſupplyed to them) and conſequently cou'd produce nothing; whereas by this *Viciſſitude* of Heat and Cold, what is rais'd in the Day-time, has time to ſettle and conſolidate in the Night, and it's Cold runs the thin

Juices

Juices firſt into thick, ſizy, Subſtances, which the ſupervening Heat, by exhaling the watery Parts (which are now brought nearer the Surface of the *Plant*) does harden and fix. This we evidently ſee in *Nutgals*, and the other Excreſcences of the Leaves of *Vegetables*; and generally, Countries that have moderately cool Nights, produce *Vegetables* of the firmeſt Union of Parts; and very hot Countries, ſuddenly bring up their Seeds, but their Parts are leſs firmly ſtuck together; they may be heavier, but not ſo tough or hard, tho' this too depends much upon the Conſtitution, and firſt make of the Seed. On the other Hand, had not the *Earth* mov'd upon its *Axe*, but only turn'd round the *Sun* in its *annual Period*, we had not only loſt all theſe Advantages, which are ſo beneficial, if not abſolutely neceſſary to the Being of our *Animals* and *Vegetables*, but we had ſuffered alſo ſuch Inconveniencies, as neither of theſe cou'd poſſibly bear; for then, for very near one half of the Year we ſhou'd have been in perpetual Darkneſs, the Conſequence of which wou'd have been, that firſt baleful and *ſulphurous* Damps (by the Forces of the preceding Heat generated and rais'd,) wou'd have fall'n, which wou'd have ſtifled all the *Animals*, or had they ſurviv'd that, by Degrees, exceeding Rains wou'd have

have been pour'd down (as the Vapours became cooler) next Sleet, then Snow, and Ice, and Froſt, which wou'd of neceſſity, not only have lock'd up all Fluids, but wou'd have freez'd the Blood and Spirits in the Channels, of all the *Animals* we are acquainted with; for as I have ſhewn before, there is a ſaline Body conſtantly ſwimming in our Air, which by the Preſence and Action of the *Sun*, is ſo attenuated and reduc'd into ſo ſlender Particles, whoſe Points (being eaſieſt broken) by the Force of the Fluid of Light are firſt beat off, as not to be able to do any Dammage; But in *his* Abſence, they ſhoot themſelves into oblong ſharp Wedges, which ſtick together the Parts of all Bodies. Now in a half Years Abſence of the *Sun*, in what Quantities, and with how much firmneſs wou'd theſe ſaline Bodies have form'd themſelves! Certainly nothing that moves, whether *Animate* or *Inanimate*, wou'd have been able to ſupport ſuch a cold. And all this is not only demonſtrable *à priori*, but is Matter of Fact, and actually happens in thoſe Places that are under the *Poles*, during a much ſhorter Abſence of this *glorious Star*. Again, in the enlightned half of the Year, we ſhou'd have had, firſt huge Deluges of melted Waters, from the preceeding Snow, which likewiſe wou'd have produc'd ſuffo-

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cating Miſts; next all our Ground, wou'd have turn'd into a ſtiff ſtinking *Puddle*, (being in a manner diſſolv'd by the Force and Quantity of the Snow Water) then wou'd *ſultry Heats* and a burning Air have ſcorched and chapp'd the Earth and gall'd the animal Tribes, that they ſhou'd have found reſt, neither in Houſes nor Dens; 'till at laſt the Heat encreaſing without Abatement, the Blood and Spirits of all the *Animals* of our *Globe*, wou'd be quite exhal'd, or they turn'd delirous by the violent Agitation of the Blood and Spirits, and then dy'd in *Convulſions*, like ſo many Puppies in the *Dog-Days*; for it were abſolutely impoſſible, that any thing that has Life ſhou'd reſiſt ſuch a Degree of Heat. It's true, there are ſome People live under the *Æquator*, yet they have but an uncomfortable time on't, tho' they are ſupply'd with conſtant Breezes and Trade-winds, ariſing from the *Earth*'s *Rotation* about her *Axis*, and prodigious Quantities of Rain, falling by the Plenty of Vapours, rais'd by the Days Heat, and let fall by the ſupervening Cold of the Night, having as long a Night as they have a Day, which is a mighty Relief, the continued uninterrupted Action of *Sun*, being by much a far harder part, than the Degree of the Heat at ſtated Seaſons. And as for the *Poles*, we have very certain Information, that few

if

if any at all, inhabit near 'em. The extreme Degrees of Heat and Cold that happen there, being incompatible with an *Animal* Life. But that which makes the Caſe much worſe than in any part of our *Globe*, upon this Suppoſition, is, that the Rays of the *Sun* wou'd be both direct, and there cou'd be no Rains nor Winds becauſe it is the cooling of the Air, that is the cauſe of both; which by no means cou'd happen in our Caſe, every ſucceeding Hour heating the Air to a greater Degree than the former. Add to all theſe, that our Seas even notwithſtanding our *Tides*, wou'd either be exhal'd, or turn'd into Deſarts of Salt, and ſo, not only our Fiſhes wou'd be deſtroy'd, but we cou'd have no freſh Waters, ſeeing we cou'd have no cool Air to ſend them down: If we had any *plants* or *Vegetables*, they wou'd be but of one particular kind, *viz.* thoſe which require the greateſt Degrees of Heat, but it is demonſtrable we ſhou'd have Occaſion for none; for any Body who underſtands the *Animal Oeconomy*, will eaſily ſee that no *Animal*, ſuch as we have on our *Globe* now, cou'd bear ſuch an exceſſive and uninterrupted Degree of Heat. Upon all which Accounts it is very plain, that the preſent *Rotation* of the *Earth*, about her *Axe*, is one of the

moſt

moſt ſignal Inſtances of Wiſdom and Contrivance, that can be imagin'd.

§ XXV. Next let us combine this *Diurnal Rotation* of the *Earth*, about its own *Axe*, with the *Annual Revolution* of the ſame about the *Sun*, and the *Parallelism* of the *Axe*, of the *Diurnal Rotation* with it ſelf. And from thence we ſhall have the beautiful Seaſons of the Year; Seed time, and Harveſt, Summer, and Winter; the comfortable Viciſſitudes of colder and warmer Periods, of Snow, and Rain, Winds and Calms, of ſhorter Days, and longer Nights, and again of longer Days, and ſhorter Nights, and of all thoſe delightful Changes, which are ſo Pleaſant, Comfortable, yea, and Neceſſary in our preſent Circumſtances. If the *Earth* had only turn'd about her own *Axe*, once in twenty four Hours, then all our *Viciſſitudes* wou'd have been of Days, and Nights; which by no means wou'd have been ſufficient for *Vegetation*. If the *Earth* had made a *Period*, about the *Sun*, once in the Year, without any *Rotation*, we ſhou'd have had but one long Day, and another equal Night; which as I have ſhewn, wou'd not have agreed, neither with Life, nor Vegetation. If both theſe had been united without the third of the *Parallelism* of the *Axe* of the *Diurnal Rotation* to it ſelf, we might have had Days and Nights, but our

other

other Seaſons wou'd have been uncertain, and in ſome Places none at all; and ſo the Effect of the annual Revolution wou'd have been deſtroy'd in ſome Meaſure. But by this wiſe Conjunction of all theſe three Modifications, we enjoy our Seaſons, and the other conſequent Changes of the Year, which are of ſo great uſe to us; for had we enjoy'd a conſtant uniform Seaſon all the Year round, ſuppoſe of Summer Weather, then our Ground had been exhauſted, and worn out by conſtant bringing forth of *Vegetables*, and wou'd have run into Weeds, and thoſe other Plants that require the leaſt rich Soil, and moſt Heat only; ſo that in a few Years the *Earth* wou'd have been reduc'd into a *Wilderneſs* of needleſs Herbs; for toward the Production of the more uſeful Plants, there is requir'd (beſides a certain Degree of Heat and Moiſture,) a *Lixivial Nitrous* or *Urinous Salt*, which keeps the Mould looſe (for receiving the moiſt Air, and for the entry of that Heat and Moiſture.) For tho' *Salts* conſolidate Water, which conſiſts of ſolid porous Parts, whereby their Particles are ſtuck together, yet they keep the Parts of Mould or Sandy Clay (which has little or no Water) aſunder, and looſe, by the ſame very Reaſon, for their Particles not allowing them entry into themſelves, they get betwixt

betwixt 'em, and first separate their Union and then keep 'em from coming together; and perhaps both forward the Motion of the Liquors in the *Vegetable* Channels (which are certainly endow'd with some Degree of *Elasticity*, and capable of being stimulated, as is evident in younger Twigs and Branches, as well as *Animal* ones) and endows the Juices with the Qualities the *Plant* requires. Now these are either quite exhausted, or destroy'd, by constant Growth and *Vegetation*. We see the best Ground wears out in a few Years, and turns into wild useless Weeds; and all the Materials for enriching Ground, are gathered from Places, debarr'd from the Action of the *Sun*, and the Expences of *Vegetation*, but expos'd to the Air, and Weather, whereby they are impregnated with this *Nitrous* or other *Salts*: Such are old Turf, new Mould, the Dung, and Excrements of *Animals*, or those things which abound with *Lixivial Salts*; such are burnt Wood, burnt Turf, Stubble, and the like. Now all these, wou'd by a short Time's uninterrupted *Vegetation* have been quite spent. Add to these, that in a perpetual *Summer*, there wou'd not fall sufficient Quantities of Rain, to moisten and soften the Mould, to that degree that it is necessary for constant *Vegetation*; for we find there is twice or thrice as much Rain falls

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in the *Winter* ſix Months, from *September* to *April*, than in the *Summer* ſix Months; and yet all this is but ſufficient for one ſix Months *Vegetation*. Moreover, even the *Animals* themſelves, cou'd not conveniently bear a perpetual *Summer*; for we find now, that the cold of the *Winter*, by ſtopping the Pores of the ſenſible Perſpiration, keeps the Warmth more within, whereby there is a greater Quantity of Spirits generated, the Blood is leſs rarify'd, the natural Functions are more ſtrong, and perform'd with more Vigour, the Digeſtion is better, the ſenſible Excretions more natural, and leſs violent, and the Crudities of the preceding *Summer* are ſettled and digeſted, I mean, in healthful and ſound *Animals* (for the Caſe is quite otherwiſe in *Valetudinary ones*, as of neceſſity it muſt be) and in a moderate and not over tedious *Winter*; whereas in *Summer* the Blood is more rarify'd, the Spirits more exhauſted, the *ſenſible Perſpirations* more violent, and leſs natural, the Digeſtion worſe, and all the Concoctions leſs thoroughly perform'd. So that it is evident we cou'd bear neither of theſe States perpetually, the Change of the *one* being abſolutely neceſſary to qualify the Errors and Extreams of the *other*. If we had a perpetual *Summer*, we ſhou'd be reduc'd to meer *Skeletons*; if a perpetual *Winter*, we ſhou'd

turn Dull, unactive *Drones*. Now perhaps againſt all theſe it may be objected, that there are rational Creatures, who inhabit this *Globe* of ours, who are perpetually in both theſe Extreams, and yet are found to be not at all diſpos'd, as I pretend they wou'd be. To this I anſwer, that tho' as to the Preſence or Abſence of the *Sun*, they may be much the ſame as I ſuppoſe, yet, there are other concurring Circumſtances, which ariſe from the *Viciſſitudes* of the Seaſons in the other Parts of the *Globe*, which alters the Caſe quite; for there are conſtant Seaſons of Rain, in the more *Southern* Countries, which fall for ſome conſiderable time, that both hinders the perpetual *Vegetation*, ſoftens the Mould, and fattens it for the next Crop; there are Clouds of Snow, and Rain, impregnated with theſe *nitrous Salts*, which are driven (by the Force of the Winds) from colder into theſe hotter Countries; and there falling, do enrich the Ground. Beſides that, even the Clouds, rais'd from theſe hotter Countries themſelves, when diſtill'd into Rain, are ſufficient for this end; for as I have ſaid before, the Air every where is full of ſuch *Salts*, as is known by Experiment. Let any one conſult *Varenius*, and he will be ſatisfied that theſe Southern Countries have *Winters*, tho' not of Snow, yet what is abundantly ſufficient to

to ſtop the perpetual *Vegetation*, to moiſten, ſoften, and fatten the Mould, and to cool the Blood, and other Fluids of the *Animals*. Now the Principal thing that makes this *Poetical* ſtate of a Perpetual *Summer*, unfit for the preſent Conſtitution of the *Animals* and *Vegetables*, is, that in ſuch a ſtate (either ariſing from only a *Diurnal Rotation*, without an *Annual*, or an *Annual* without a *Diurnal*) there wou'd not be that variety of Rains, and cool Breezes, nor conſtant, and Trade-winds, nor overflowing Rivers, and ſuch like Circumſtances, which are the Effect of this Combining theſe two Motions together. I need not ſhew the Inconveniencies of a perpetual *Winter*, every Body is ſufficiently ſenſible, that upon ſuch a Suppoſition, we ſhou'd have neither *Vegetable* nor *Animal* in a very ſhort Time; eſpecially of any conſiderable uſe, or value, ſuch as require a *Summer's* Heat, for their Growth; and as for *Spring* and *Autumn*, they are not ſo much diſtinct Seaſons from the two former, as Gentle *Gradations* and eaſie Steps, whereby the one ſlides into the other, through the intermediate Degrees. From all which it is evident, how wiſely theſe three ſo different Modifications, have been link'd together, for the Benefit of the Inhabitants of this *Globe*; for by theſe, we have ſufficient Heat in *Summer*, to ripen

the Fruits that are the product of every respective *Climate*; and we are furnish'd with Reason, and made capable of Industry, to transfer the Products of one Country to another; we have Rain, and cooling Breezes in the *Winter*, of those Countries, where Heat is not wanting, to cool, soften and enrich the Mould, and to stop constant *Vegetation*; and we have Frost and Snow in others, where the Heat is not to spare, to lock up the Mould from being wash'd away, and to keep in either the natural, or adventitious Heats, 'till the time that all Circumstances concur, to have the product of the Ground brought to its *Vegetations*.

§ XXVI. Come we now to consider the *Obliquity* of the Plane of the *Ecliptick* to that of the *Æquator*, or of the *Axe* of the *Diurnal Rotation*, to the Plane of the *Annual Orbit* of the *Earth*, which makes an *Angle* of 66½ Degrees. I have already shewn, that if the *Equator* and *Ecliptick* had coincided, it wou'd have rendred the *Annual Revolution* of the *Earth* quite useless; for if the *Earth* had mov'd about its own *Axe*, and this *Axe* had been at right *Angles* with the Plane of the *Ecliptick*, the same Appearances as to the *Vicissitudes* of Day and Night, had happen'd, whether the *Earth* had mov'd round the *Sun*, or not; and the Alterations of Seasons, and all the Conse-

quences

quences thereon depending, had not been at all; and what a hinderance this wou'd have been to *Life* and *Vegetation*, I have already ſhewn. Beſides that in the *Torid Zone*, the Heat wou'd have been intolerable, and not to have been endured; and in the *frigid Zones*, the Cold wou'd have deſtroy'd both *Animals* and *Vegetables*; and even in the *Temperate Climates*, the one half of 'em wou'd have made but a very comfortleſs Habitation, for ſuch Creatures as we now are; ſo that but only the other half, wou'd have been any ways, a tolerable Seat for rational Creatures, and five Sixths at leaſt of the whole Globe, wou'd have been rendred uſeleſs. But *God* who is wiſer than Man, has contriv'd the Matter much better; for by this preſent *Obliquity* of the *Ecliptick* to the *Equator*, we reap one very conſiderable Advantage, which is taken notice of *by my very learn'd and ingenious Friend* Dr. *John Keill*, and that is, that we beyond the forty fifth Degree of *Latitude*, and who conſequently have the greateſt need of *Sun*'s Heat, have more of it, take the whole Year about, than if the *Sun* had mov'd continually in the *Equator*; and they that live in the *Torrid Zone*, and the adjacent Places, even to the *Latitude* of forty five Degrees, who are rather too much expoſed to the Heat of the *Sun*, than too

little, have by these Means, less of his Heat, than they wou'd have had, had the *Earth* observ'd a right Position. To these add, that since this *Globe* of ours, has been design'd for a Habitation of rational and irrational Creatures, of various *Tempers*, *Constitutions*, and *Dispositions*, and for *Vegetables* of different *Natures* and *Virtues*, requiring different Degrees of Heat, and Nourishment, to Ripen, and to bring 'em to Perfection, (to shew the *manifold* Wisdom of the *Author* of *Nature* in the Variety of every thing.) And since we find the present Heat of the *Torrid Zones*, very well fitted for all the kinds of *Animals* and *Vegetables* that inhabit and grow there, the Cold of the *Frigid Zones*, very tolerable to the *Inhabitants* and *Productions* of these Places, and the *Temper* of the intermediate ones, suited to theirs; those *Animals* that cannot transport themselves, and the *Vegetables* that require a greater Degree of Heat, not having too much, and the like *Animals* and *Vegetables*, that can suffer Cold, not having too little Heat, and the rational Creatures being endow'd with Reason and Means, to transport themselves where they live most at ease. And since it was impossible to have accommodated, all these so various and different *Animals* and *Vegetables* in a place of an equable and uniform, (or in one, and

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the ſame) *Climate*, it's evident that the preſent Situation of the *Axe* of the *Earth*, to the Plane of the *Ecliptick*, is the beſt (of that infinite Variety poſſible) that cou'd be, for our preſent Circumſtances; for by any other very conſiderable *Alteration*, all or moſt of the mention'd Advantages would be loſt. For all which Reaſons we can never ſufficiently admire the *Wiſdom* of the *Author* of *Nature*, who has provided ſo liberally, and prudently for his Creatures.

§ XXVII. The ſame divine Wiſdom, is conſpicuous, in the Situation of the *Earth* in reſpect of the *Sun*; for had the Diſtance between the *Earth* and the *Sun*, been the ſame with the Diſtance between *Mercury* and the *Sun*, *i. e.* were we brought three times nearer the *Sun* than we are, or the *Sun* brought three times nearer us than he is, our Ground in Winter, wou'd have been hotter than red hot Iron, and what a Condition we ſhou'd have been in then, we may eaſily gueſs. On the other Hand, had the *Sun* been remov'd from us, or we from the *Sun*, to the Diſtance *Jupiter* or *Saturn* are remov'd, our hotteſt *Summers Day* had not afforded ſo much Heat, as thoſe that now live under the very *Polar Star* (if any ſuch there be) of our Globe, feel in the midſt of Winter. Are not we then very wiſely provided for, who are put in ſuch Mediocri-

ty, between these two extreme Distances, that neither our Heat nor Cold is so violent; but that we may either endure 'em, or with a little Industry fence our selves against their Injuries? Again, as to the *Figure* of our *Earth*, we are certain from its Shadow in the *Eclipses* of the *Moon*, and a great many other experimental Observations that it is *Spherical*, *Spheroidical*, or *Orbicular*: Bating the inequalities the Mountains make, and this Figure is a wise and beneficial Contrivance, not only as it is the most Capacious, and renders all the parts of its Surface equidistant from its Center of Magnitude, and also from its Center of Gravity pretty nearly, whereby the equability of its *Rotation* about its *Axe*, and of its *Circumvolution* in its *Orbit* is preserv'd, and all the Motions on its Surface in all its Parts are rendered Uniform and Similar. But also, as the *Ingenious and Reverend* Mr. *Derham* has observed. 1. Because this Figure is the fittest of any for a regular and gradual Reception and Surrendry of Light and Heat, both these being admitted, and given of, by more slow, creeping, and insensible Degrees than they cou'd be were the *Earth* of a Figure made of plain sides or any other Figure whatsoever. 2. Because this Figure is the fittest for a regular and equal Distribution of the Waters, which being a hea-

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vy Body, wou'd fall more unequally towards ſome one ſide or other, were the *Earth* of a Figure made up of equal or unequal Plains. 3. Becauſe this Figure is the moſt proper for an uniform and equal Diſtribution of the Winds and the other Motions of our *Atmoſphere*, for we find, that large *Mountains*, *Bays*, *Capes*, and *Headlands*, alter and diſturb in ſome meaſure the uniform Propagation of the Winds, even of the general and conſtant *Trade-winds*, and if the *Earth* were of a *Multiangular Figure*, the advantages ariſing from regular Winds and Fannings of the Air wou'd be diſturb'd and deſtroy'd to a much higher Degree. Now theſe are ſome few of the Advantages of an *Orbicular* Figure in general, but as to the prolate *Spheroidical* Figure in particular, tho' it be the neceſſary Reſult of the *Earth's Rotation* about his own *Axe*, and the Fluidity of its ſuperficial Parts, at the Commencement of this Rotation; yet it alſo is very convenient for us. By the *Earth's* Motions about its *Axe*, the Parts endeavour to recede from the ſame *Axe* as much as they poſſibly can, by a *centrifugal* Force, ariſing from the circular Motion; and therefore, if the Matter of any of the Heavenly Bodies, was Fluid, at the Commencement of this circular Motion, it wou'd neceſſarily have riſen from the *Poles*, and accumulated

cumulated at the *Equator*, and so induced a *spheroidical* Figure on the *Planets* Body, generated by the *Circumvolution* of an *Ellipse* about its lesser *Diameter*. Now since it is evident to our sight, assisted with a good *Telescope*, particularly, in *Jupiter*, that the *Diameter* at the *Equator* is longer, than that at the *Poles*, and since Sir *Isaac Newton* has demonstrated that *Earth* is as least seventeen Miles higher at the *Equator* than at the *Poles*, and since many repeated Experiments on the lengths of *Pendulums* in different Latitudes have confirm'd the same, its plain that at the Commencement of the diurnal Rotation, the Surface of the *Planets* has been covered with a Fluid; which gives an Account why at every forty or fifty Fathoms, below the Surface of our *Earth*, we never miss of Water. It is likewise evident from this Figure of the Body of the *Planets*, that the Surface of the *temperate Climates* is larger than it wou'd have been, had the *Globe* of our *Earth*, or of the *Planets*, been either *spherical* or *oblongly spheroidical*; so that the Advantage of this Figure is very considerable, the Surfaces of the *Polar Regions*, which by reason of the oblique Incidence of the Rays of the *Sun* upon them, are colder, and less convenient for the Habitation of *Animals*, and the Production of the nobler Sort of *Vegetables*, are

are hereby conſiderably leſſened, and the Surfaces or Space about the *temperate Zones*, which are moſt comfortable and uſeful, are thereby conſiderably enlarged. The ſame Figure obtains not only in the *Earth*, and the reſt of the *Planets*, and their *Satellits* but likewiſe in the *Sun*, and univerſally in every fluid Body revolving about an *Axe*.

§ XXVIII. Having ſhewn ſome of the Advantages ariſing from the ſeveral Motions of the *Earth*, and the Combination of theſe, which are common to the other *Planets*, I come now briefly to conſider, thoſe that poſſibly may be more particularly belonging to our *Globe*, and are not the immediate Conſequence of its Motions; and the firſt in order is our *Atmoſphere*, of ſuch Neceſſity toward the ſubſiſtence of *Animals*, and the growth of *Vegetables*, that neither cou'd ſubſiſt any conſiderable time without it. This *Atmoſphere* is a thin *elaſtick* Fluid, intermixt with Particles of different Natures, ſurrounding our *Globe* to the heighth, of about forty or forty five Miles. The Nature and Properties of this Fluid, I have in ſome meaſure ſhewn already. But ſome of its uſes I ſhall now point out, and firſt as to *Vegetation*, Dr. *Grew* and *Malpighi* have ſhewn that it is a principal concurrent therein, and by Experiments on Seeds ſown in Earth and put in an exhauſted *Receiver*,

*ceiver*, it has been proved that no *Vegetation* can ſucceed without it, what makes it ſo neceſſary ſeems to be becauſe it being more eaſily rarified, and heated by the *Action* of the *Sun*, than other more compact, heavy, and leſs *ſpringy* Fluids, is fitter to promote the Aſcent of Juices in the ſlender Channels of *Vegetables*, and there being no Fluid without a conſiderable Portion thereof, lodged up and down among its Parts, the firſt impulſe of the Juices upwards, does thence ariſe. As alſo becauſe of its active, ſpringy and ſubtile Nature, it rarifies, actuates and refines the more fizy *Vegetable* Juices to promote their Circulation and performs Functions, on them *Analogous* to that it does on the animal Fluids. Next as to *Animals* it is well known, that they cou'd live but a few Minutes without this *elaſtick* Fluid, and probably that which ſo ſuddenly kills thunder-ſtruck *Animals*, is the quick and violent Rarefaction of the Air about them; for the *Lungs* of all ſuch upon opening, are found quite deſtitute of Air, and the ſides of their *Veſicles* quite clapp'd together. It's certain, that the Blood is ſent from the right Ventricle of the Heart to the *Lungs*, and if the Veſicles thereof be not diſtended or blown up, by the Air, the *Circulation* muſt ſtop there, and the *Animal* periſh; and both for the Comminution

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of the Particles of the Blood, that they may more eaſily paſs through the *Capillary* and terminating Veſſels, and for the Propagation thereof in the wider ones, there is neceſſarily requir'd a Fluid of a determinate Gravity, and *Elaſticity*. We have as great Difficulty of Breathing, in a thin (as is evident from the difficulty of Breathing on the tops of high Mountains, and from Experiments on Animals in nearly *exhauſted Receivers*) as in a thick Air; and ev'n in *Fiſhes*, where the Water in ſome meaſure ſupplies the want of Air, yet if you draw out all the Bubbles of Air, which are always found in Water, they will languiſh and die; and in great Froſts, if the Ice be not broken to admit freſh Air, the *Fiſh* in *Lochs* and *Ponds* will languiſh and die, not to mention here their *Swimming-bladders*, which are ſo neceſſary to them, and communicates with the Air in their *Gills*. So that even to them, a certain Portion of this *elaſtick* Fluid, is neceſſary. Now how well is this Fluid fitted for the generality of the Inhabitants of this *Globe*? It being neither too heavy, nor too light, neither too much, nor too little *Elaſtick*, for the uſes of Reſpiration. Another Advantage we reap by our *Atmoſphere*, is, that by it our *Clouds* and *Vapours* are ſupported, without which we ſhou'd neither have freſh Water, nor Snow,

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nor Rain, nor any of those things, which moisten and enrich our Soil, and make it fit for *Vegetation*. For tho' it be the *Sun* that rarifies the Water, and makes it take its first flight in *Vapours*, and *Steams*; yet its by the *Atmosphere*, its Progress is continued to the upper Regions, and supported when it is there, to be afterwards form'd into Snow, or Hail, or Rain, or carried into other Regions, whose Soil does want it more. Every Body knows, that if there were no *Atmosphere*, but a perfect *Void*, around the *Earth*, the Action of the *Sun*, wou'd not be able to raise the *Vapours* above a few feet, from its Surface; and that it's only the *Atmosphere*'s being *specifically* heavier, than these *Vapours*, that buoys 'em up in the Air, by its greater Tendency toward the Center. Now then, if there were no *Atmosphere*, the *Vapours* cou'd rise to no sufficient heighth, and so cou'd never be cool'd sufficiently, so as to be form'd into Snow, or Rain; for at a small distance from the *Earth*'s Surface, the reflected Rays of the *Sun*, make the Places so warm, that no *Vapour* cou'd be turn'd into Snow, or Rain, there; for it's the coldness of the upper Regions, (being destitute of these reflected Rays) and the length of their Descent, that forms these *Clouds* and *Vapours* into Snow, and Rain, whenever the supporting *Atmosphere* becomes

becomes lighter, than these accumulated *Vapours*, they fall down with the Temper of Heat or Cold, they had in the *upper Regions*, and so became Snow, or Rain accordingly. So that it's plain, it's our *Atmosphere* that is one of the principal Means of our Dews, and Rains, and all the Blessings, that follow upon these. A third Advantage of our *Atmosphere* is, our *Breezes* and our *Winds*, which carry our Ships upon the *Sea*, and purify our Air, from noxious Steams, which (with the Concurrence of the *Sun*) melt our Snows, and dry our Ground when over-moistned; and serve for so many other Purposes, for the Accommodation of Humane Life. *Wind* is nothing but a violent Motion of the Air, produc'd principally by its Rarefaction, more in one Place than another, by the *Sun*'s Beams, the *Attractions* of the *Moon*, and the Combinations of the *Earth*'s Motions. Without our *Atmosphere*, we shou'd have no more *Wind* above, than under Ground, and so be depriv'd of all the Benefits arising thence. Lastly, Our *Atmosphere* is the Vehicle and *Medium* of Sound, that Sense which mostly distinguishes us from *Fishes*, and the inferior sort of *Insects*. *Sound* is nothing but a *Modulation* or *Percussion* of the Air, communicated by an impulse, from the vibrating sonorous Body, and propagated in *Undulations*,

*dulations*, through the Fluid of the *Atmosphere*, ev'ry way round. Without our Air we shou'd not be able to hear the Report of a thousand Pieces or Ordinance discharg'd at the smallest distance, as is evident from the Experiments on Sounds in exhausted *Receivers*. We shou'd have no such thing as Languages or *Musick*, and what a comfortless state this wou'd be, I leave the Reader to judge. Add to all these, that it is to our *Atmosphere* the Beauty, variety of Colours, and Figures, which are painted on the Skies, the Lightsomness of our Air, and the *Twilight* are owing. By it the day is protracted, and the night shortened, and in these places most, which want those most. By the *Refractions* of our *Atmosphere*, the *Sun* rises sooner, and sets later in Appearance, and with its beneficial Consequences, even a Month sooner in some places than it would otherwise. And the Land and Mountains, appear sooner to the weary wandring Sailor. These are great and noble Advantages to the Inhabitants of this Globe, as they best can tell, who by Accidents are sometimes deprived of them. From all which it's very plain that there was *Counsel* and *Design* in the Contrivance and Production of our *Atmosphere*.

§ XXIX. The next thing in Order to be considered is, our *Mountains*, without which

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it were almoſt impoſſible for *Animals* to ſubſiſt, or *Vegetables* to grow, they being one of the principal concurrent Cauſes toward the Production of our freſh-water Rivers. It has been ſhewn from Calculation, by ſeveral Perſons, and particularly the ingenious and learned Profeſſor of Geometry at *Oxford*, Dr. *Ed. Halley*, that the *Sun* raiſes Vapours from the Surface of the Sea, in a Year, ſufficient to ſupply all the Rivers with freſh Water for that time. Now theſe Vapours being rais'd (the *Sun* acting upon the Surface of the Sea, as a Fire under an *Alembick*, by rarifying the ſame, it makes the lighteſt, *i. e.* the freſheſt Portions thereof, to riſe with it firſt; and it rarifies the Water by the Inſinuation of its active Particles among the porous Parts thereof, whereby they are put in a violent Motion innumerable different ways, and ſo are expanded by the compound Fluid of Heat and Air, or hot Air, which carries up with its every little *Volum*, a *Cover* of the more glutinous Fluid of Water which becomes a little *Bubble* of hot Air incloſed within a ſhell of Water, whereof a great number conſtitutes a Vapour, which being thus form'd into little *Bubbles* of larger Dimenſions than they formerly had, by the inteſtine Motion raiſed by the Heat on the Air and Water, which makes their parts turn round their

Centers of Gravity, and so to possess more Space, and likewise to fly from one another, and by these means being become *specifically* lighter, they are buoy'd up by the weightier *Atmosphere*) and that this is pretty nearly the Fact, in the production of *Vapours*, may be evident to any one who will view these Vapours raised from common water, by a culinary Fire with a *Microscope*, through a Beam of the *Sun*, which will presently be seen to be innumerable little Bubbles of Water, of different Magnitudes according to the different Force of the Heat in blowing them up. A small Heat throws off but few Vapours, and small Bubbles, a greater Heat, grosser, larger, and more numerous *Globules*. And a very great Heat, so weighty, large, and many *Vesicles*, that the Air is not able to receive and buoy them up, and so produces a boyling in the Water. And every one knows that cold solid Bodies, intercepting Vapours, will condense them into Moisture, watery Drops, and Water. From all which it is evident that *Vapours* may be raised by the *Sun* in such Quantities, as is sufficient to make Clouds, which resting in those Places, where the Air is of equal Gravity with them, are carried up and down the *Atmosphere*, by the Course of that Air, 'till they at last hit against the sides of the more eminent and

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*Mountanous* Places, of the *Globe*, and by this Concuſſion are condenſed, and thus become heavier than the Air they ſwom in, and ſo gleet down the rocky Caverns of theſe *Mountains*, whoſe inner Parts being hollow, and ſtony, afford them a *Baſon*, 'till they are accumulated in ſufficient Quantities to break out at the firſt *Crany*; whence they deſcend into the Plains, and ſeveral of them uniting, form Rivulets, and many of theſe Rivers; ſo that it is evident the great Beneſit of theſe Eminences is not, that by the Shock theſe Vapours get in their Courſe from them, they are condens'd, ſo as to be precipitated thereby through the Chinks of the Rocks, but that afterwards in their Bowels they are preſerv'd, 'till they be of ſufficient quantity to form Rivulets, and then Rivers; for doubtleſs our Vapours wou'd fall in Rain, and Dew, tho' there were no *Mountains*, but then they wou'd fall equally, over conſiderable Places of the *Globe* at once, and ſo wou'd be ſuck'd up in the Ground, or make an *univerſal Puddle*; whereas by theſe *Mountains*, they are perpetually almoſt, (at leaſt a Nights) pouring down in ſome particular Places, and there treaſuring up, for a conſtant Supply to the Rivers. Not that other Cauſes may not concur toward the Production of Fountains, Rivers, and freſh Water, beſides the raiſing of Va-

pours by the Heat of the *Sun*, to descend in *Rains*, *Mists*, and *Dews*. They might be raised from the *Sea* by *Subterraneous* Heats, and percolated from their Saltness, by being strain'd through Earths and Layers of Minerals of different Natures; but it is not easy to conceive, how any straining can bring salt Water to that degree of freshness, our Rain, and Snow Water is brought. All the artificial strainings, tho' never so often repeated, and through whatsoever kind of Sands or Earths, hitherto discovered and made use of, still leave a *Brakishness* in salt Water, that makes it unfit for *Animal* uses; neither does there appear any kind of natural Operation, sufficient for this purpose, but this natural *Sublimation* and *Distillation* of Vapours into *Dews*, *Mists*, and *Rains*, which makes it very probable that this is the principal efficient in the Production of Rivers and Fountains. As to the *perpetuity*, and *equability* of some Fountains, where there are no considerable Mountains over and above what is to be expected from the uncertain and unequal falling of *Rains*, *Mists*, or *Dews*, nothing can be concluded from thence, unless the Extent and Capacity of the *Reservoirs* of falling Rains in the Bowels of the Earth were certainly known. For the fresh Water may be convey'd to so great a distance, and in such a quantity,

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and to ſo great a depth, by the ſituation of the internal Channels, as may be ſufficient to raiſe it in larger Streams, than any Fountain Head as yet known can ſend out, and the depth and diſtance of the Baſon may hinder it from ſending out *Senſibly*, more Water at one time than another. Tho' if the Quantity were preciſely the ſame at all times, in theſe *perennial* Fountains, the difficulty wou'd be greater. However, whatſoever the Origin of Fountains may be, ſtill Hills are the *Reſervoirs* in this great Work. Another very conſiderable uſe of theſe *Hills*, and *Eminences*, is the Determination of theſe Rivers; for tho' there had been Rivers without Mountains, (which is hardly poſſible) yet in that caſe the Rivers cou'd only have run in a ſtraight Line, if they had run at all; whereas, by theſe *Eminences*, plac'd up and down the *Globe*, the Rivers make innumerable beautifying turnings and windings, whereby they enrich, fatten, and water the Soil of ſeveral different Countries in one Courſe, make the Tranſportations and Carriage over Lands more eaſy and manageable, and at laſt diſembogue in ſeveral Mouths into the *Sea*; where, by the aſſiſtance of the *Tides*, they form Harbours and Ports, for the convenience of *Shipping* and *Navigation*. All theſe Advantages we have by our *Mountains*; for tho' from other Cauſes,

we might possibly be supply'd with fresh Water *Springs*, (tho' Nature seldom is *Luxuriant* in diversity of Causes) yet without our *Mountains* we cou'd never have Rivers, nor cou'd these Rivers have such delightfull turnings, nor those useful falls, which gives them an impetuosity that may be improv'd to so many delightful as well as profitable Uses. Lastly, If we consider what these Hills in their own Nature and Cause are, we shall plainly perceive their Necessity and Use: A Hill, is nothing but the *Nest* of some *Mettle* or *Mineral*, either of *Stone*, *Iron*, *Tin*, *Copper*, or such like lower *Vegetables*: These *Mettals* and *Minerals*, by a *plastick* Virtue proper to themselves, and the efficacy of *subterranean* Heat and Fires, converting the adjacent Earths into their Substance, do encrease and grow as truly as *Animals* or *Vegetables*, and requiring free Passage both for Air and Water to assist in their formation: By their Growth, and the Heat of the subterranean Fires, raise and push upward the Surface of the Earth according to the necessity of their Nature, and the quantity of the *Metallick* or *Mineral* Bed. I do not say that all Mountains owe their *Origin* to such Causes, *subterraneous* Fires have thrown up Mountains of *Mineral* and *Metallick* Beds, already form'd, the *Sea* and *Tides* have thrown up Banks and Bays of Stone and Sand, Currents

rents and Streams in proper Situations, meeting and juſtling have form'd Eminences of different Sizes and Matter: And Art and humane Induſtry has raiſed ſome. But generally and for the moſt part, all the eminent Mountains are found to be Neſts, and Beds of *Minerals* and *Mettals*, which have large hollow Cavities, for Water and Air, and whenever they have been digg'd into, theſe have been found in them, with all the appearances of ſome parts of them a forming and growing in a manner proper to them, and *analogous* to the Vegetation of Plants. The manner how they are produced is not here neceſſary to be enquired into, but that *Mettals* and *Minerals* are encreaſed and do grow is paſt all doubt, and is confirm'd by all Miner's and Diggers: And that there may be *ſubterraneous* Heats ſufficient to raiſe them into *Hills* and *Mountains*, is evident from ſome, ſo formed near *Vulcano*'s and burning Mountains: And the Force and Violence with which theſe Burn and throw out ſuch Maſſes of *ſtony*, *ſulphurous*, and *earthy* Matter. From all which it is evident our Mountains are as neceſſary as our *Mettals* and *Minerals* are. I do not mention here their uſe and advantage for the production, ſhelter, and nouriſhment of ſome ſorts of Vegetables and Animals which cou'd not grow or live ſo well any where

elſe. But from the whole we may ſee of what Advantage theſe unſightly Mole's (as ſome thought them) are to the Accommodations and even Neceſſities of living.

§ XXX. Next come our Fluids to be conſidered, without which we cou'd never have been, ſeeing they are a very *eſſential* part of us; that which I ſhall principally take notice of, is, 1. The fewneſs of the *original* and *primary* Fluids, in reſpect of that vaſt Number of compounded ones, which are indeed numberleſs. The *primary* ones hitherto certainly known, are only four, *viz. Air*, *Water*, *Mercury* and *Light*; three of which are but ſeldom much compounded with others, ſo that it is Water alone, or *Lymph*, that is the *Baſis* of all our Mixtures, and it is the parts of ſolid Bodies floating in this Fluid, that produces all our delightful and uſeful varieties of Liquors; ſo frugal is Nature in *Principles*, and ſo fruitful and various in Effect and Compoſitions. 2. The great difference between the *ſpecifick* Gravities of our Fluids, *Mercury* being about 8000 times heavier than *Air*. Now not to mention the many uſes of this laſt Fluid in Artificers Works, had *Air* been as heavy as *Mercury*, it had been altogether uſeleſs in Reſpiration; on the contrary, it had choaked us immediately; and had there not been a Fluid of the ſame weight with *Mercury*,

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*i. e.* a collection of exceeding ſmall, vaſtly heavy *Spherules*, in the preſent Circumſtances of Mankind, I do not know what a great part of the World would have done. For the Lewdneſs and Debauchery of Mankind, has brought a great many Diſeaſes to that degree of Malignity, that I ſcarce ſee how a thorough Cure cou'd be made of 'em, without this Fluid; for it's certain whenever any Diſtemper ariſes from an obſtruction of the Blood Veſſels, wherein the Blood and its Veſſels, are chiefly concerned (for in *Nervous* Caſes I am ſatisfied it is pernicious, in great Quantities eſpecially) that this Fluid, if not abſolutely neceſſary, is extremely beneficial; for nothing has ſufficient force to take away this obſtruction, and to ſeparate the *Globules* from one another, in the extreme *capillary* Veſſels, but a little weighty *Sphere*, ſuch as the Particles of *Mercury* certainly are. Now by this difference of the *Specifick* Gravity of the Fluids, a Remedy is provided for all theſe Maladies, which I am ſatisfied are more than two or three. But that which is moſt wonderful in theſe Fluids, is, 3. The univerſal condition of the direction of their *Preſſure* upon the ſides of the containing Veſſel; for in all Fluids of whatſoever kind or nature, this *Preſſure* is communicated in Lines *perpendicular* to the ſides of the containing Veſſel.

sel. Now this property of Fluids, which is so beautiful and uniform, is the necessary Consequence of the *Sphericity* of their constituent Particles; for since by the third Law of Nature, *Reaction* or *Repulse* is always equal and contrary to Impulse or Action, in the same Direction, consequently the sides of the containing Vessel presses the contain'd Fluid, as much as the contain'd Fluid presses the sides of the containing Vessel; and this *pressure* of the sides of the containing Vessel, is directed in the same right Line with that of the contain'd Fluid, but is contrary to it. Now seeing a *right Plane*, can only touch a *Sphere*, in a point, and can press it in a direction through that point of Contact; if this Direction through the point of *Contact*, do not likewise pass through the Center of the *Sphere*, the *Sphere* will necessarily revolve upon *Plane* till the Direction of its *pressure*, from the point of *Contact* pass through the Center of the *Sphere*; just so likewise, if a *Plane* press two *Spheres*, in the same Direction, the Line of this Direction will necessarily pass through both their Centers. And so if there be any number of *Spheres* whatever, press'd by a *Plane* in the same Direction, the Line of this Direction will necessarily pass through all their Centers. But a Line through the Center of a Sphere from the point of Contact, is

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*perpendicular* to the *Tangent Plane*; and ſince this is the Direction of the *preſſure* of the *Plane* upon the *Spheres*, it is alſo the Direction of the *preſſure* of the *Spheres* upon the *Plane*. Since alſo the Particles of Fluids, are *Spherical*, or nearly approaching thereto, and ſince they are ſuppos'd exceeding ſmall, as alſo ſince *curve* ſurfaces are compounded of an infinite Number of little plain ſurfaces, it is univerſally true, that all Fluids of what nature ſoever, preſs the ſides of the containing Veſſels in a Direction *perpendicular* thereto. And on the other hand, ſince by *experience*, it is found true, that Fluids do preſs the ſides of the containing Veſſels, in a Direction *perpendicular* thereto, it's certain that the Particles of all Fluids are *Spherical*, or nearly approaching thereto; ſo that this is now no more *Hypotheſis* but *Demonſtration*. Now cou'd any thing but the Fingers, and *Almighty Power* of God, have rounded thoſe infinite numbers of ſmall Particles, whereof Fluids conſiſt? Or cou'd any thing but his *Wiſdom*, have aſſign'd them their true dimenſions, their exact Weights and requir'd Solidities? We ſhall allow him to continue in his infidelity who can demonſtrate by what Laws of *Mechaniſm*, all the Particles of Water were turn'd of the ſame *Diameter*, Solidity and Weight, and thoſe of Air,

*Mercury*

*Mercury* and *Light*, turn'd all of different *Diameters*, Solidities and Weights from one another; but all of the ſame *Diameters*, Solidities and Weights among themſelves.

§ XXXI. What a noble repreſentation of the Divine Wiſdom does our Fluid of *Light* afford us! how wonderfully are its parts fram'd! and with what a prodigious *velocity* are they ſent from the Body of the Sun! its Subtility is almoſt beyond imagination, no Pore ſo ſmall as to exclude it; no Stream of it ſo great, but may be congregated almoſt into a ſingle Point; no Surface ſo finely poliſhed, as not to ſcatter almoſt one half of it; its Rays traverſe through one another, millions of different ways, without interfering ev'n in the ſtraiteſt Paſſages; in one Word, we are not able to comprehend nor imagine a Number ſufficiently ſmall, to expreſs its ſubtility; in every pulſe of an *Artery*, it runs ſome *hundred and thirty thouſand Miles*; what an amazing, and unconceivable *velocity*, muſt this be! nothing but the action of the Mind, can any ways repreſent it: And then what a beautiful *Idea* of this Fluid, do Sir *Iſaac Newton*'s *later Diſcoveries* preſent us with, ev'ry Ray is endow'd with its own *Colour*, and its different degree of *Refrangibility and Reflexibility*. One Ray is *Violet*, another *Indigo*, a third *Blew*, a fourth *Green*, a fifth *Yellow*, a ſixth *Orange*, and the

the laſt R*ed.* And theſe are the *primary* and *original Colours*, and from the mixture of theſe, all the intermediate ones proceed, and *White* from an equable mixture of the whole; *Black* on the contrary, from the ſmall quantity of any of them being reflected; or, all of them in a great meaſure being ſuffocated. So that now it is not Bodies that are coloured, but the *Light* that falls upon them, and their Colours ariſe from their *Aptitude*, to reflect Rays of one Colour, and tranſmit all thoſe of another. Their prominent little parts, upon their Surfaces, according to their different Degrees of *denſity* and *thinneſs*, are apt to reflect back upon our *Organs*, Rays of one Colour, and of one degree of *Refrangibility* and *Reflexibility*, and to let others paſs through their Pores; and this one Colour too, is leſs or more intenſe, according as their prominent parts are of different *denſities*, or are thicker or thinner. For the firſt degrees of *Intenſeneſs*, in all the *primary* Colours, ſeem to ariſe from ſome determin'd degrees of *denſity* and *thinneſs*; and the ſubſequent degrees from the other different degrees of denſity or thickneſs or thinneſs, of the prominent little parts, of the Surfaces of Bodies. *Light* acts upon Bodies by heating, diſſolving, and putting their parts in a *vibrating* Motion; as alſo Bodies act upon *Light*, in

in drawing its parts to them, and that in Lines *perpendicular* to their Surfaces: All the differently *reflexible Light*, observes this one Law, that all the different *Angles* of *Incidences* are respectively equal to the *Angles* of *Reflexion*; and all the differently *Refrangible* Rays of *Light*, observe one Law likewise, *viz.* that in all the *obliquities* of the same Ray, to the Plane of *Incidence*, the *Sines* of the *Angles* of *Incidence*, are to the *Sines* of the *Angles* of *Refraction* in a constant *ratio*; and both these Properties proceed from one, and the same Principle, acting in different Circumstances, *viz.* that Bodies attract *Light* in *Lines perpendicular* to their Surfaces, and that this attraction is equal in all the *Incidences*, and *Refractions* at eqnal Distances from the same *Plane*, and the *reflected* Rays are turn'd back before they arrive at the *reflecting* Plane: For if the *reflecting* Plane, have such a force of *attraction*, that before the Ray arrives at it, it has already made the *Sine* of the *Angle* of *Incidence*, equal to the *Radius*, the Ray must reflect, and not enter into the reflecting Plane at all; if a lesser degree of *attraction*, then must it enter the Body of the Plane, and proceed in the Line, that its direct *impulse*, together with the degree of *attraction* in the *refracting* Body, necessarily generates. And as there

there may be different degrees of *Attraction* in Bodies, which produce their different degrees of *Elasticity* and *Cohesion*, so there must be different degrees of *attraction* in *Mediums*, suppos'd, to account for their different *Powers*, in bringing the *refracted* Rays nearer to or farther from, the *perpendicular*; for it's well known, all *Mediums* have not the same *refractive* Virtue. Now what a beautiful, uniform, and simple *Theory* of *Light*, is here? this is so very like the *frugal simplicity*, and yet the *manifold variety* of Nature, that one would be almost tempted to believe it true, were there no *Demonstration* and Experiment to confirm the truth of it. I might likewise shew here the Art and Contrivance of Nature, in the production of the *Cohesion* of Bodies. But having been pretty copious on this Subject already, I shall only suggest one very remarkable Instance of the wonderful Contrivance and Wisdom of Nature, in the *propagation* of *Light*, *viz.* that a Ray of *Light*, in passing from a luminous Point, through two differently *refracting Mediums*, to illuminate a given Point; spends the least time (the refracting Powers of the several *Mediums* considered) possible, and consequently when the Rays passes, but through one and the same *Medium*, *i. e.* when a Ray passes from a luminous point, to reflect upon a given

given point, it takes the shortest way possible. This the *Geometers* have demonstrated, and particularly, Mr. *Hugens* in his Treatise of *Light*, very elegantly *page* 40 *and* 41. Now I appeal to the Reader, how *incredulous* soever, if this be not an Instance of *Counsel* and *Design*, is not this like the Methods of *Prudence* and *Wisdom*, which will not spend more time on a thing, than just what is necessary to do the Business; which will not go about, but take the shortest Course possible, that will bring it to the place design'd? He that can resist such pregnant and powerful Instances of Divine Wisdom, will never be convinc'd.

§ XXXII. I should next proceed, to shew the wonders in the *Bowels* of our *Earth*, but there our Discoveries are so few and our accounts of this matter, so lame, that little to be reckon'd certain, can be determin'd about these *Inner Regions*. Some have concluded that there must of Necessity be a Central heat, because they saw that Springs run faster in Frost and Snow, than in hot Weather, but that might proceed from some of the other more narrow *outlets* of this *Bason*'s being stopt, by the Frost; and the *Vapours* that the Sun raises thence, being kept in. Others have thought that within this outer Crust of *Earth*, there must be a *Discontinuity*, for some considerable distance,

ſtance, quite round, and that there was ſucceeding this, a large *Sphere*, moving after a certain manner, to account for the *variation* of the *Magnet*; what Truth may be in that we muſt leave to Time and future Obſervations to determine. But the *Magnet* in it ſelf is a beautiful Inſtance of the Power and Contrivance of the *Author* of Nature, of the reality of *Attraction* in general in Bodies, and that different from their Gravities; and of their imperceptible Influences upon one another. For this wonderful *Foſſil* not only attracts and repells *Iron*, and all *Chalybeat* Compounds, and all other *Minerals* of the ſame Nature with it ſelf, according to their different Situations in reſpect of its *Poles*. But when *Iron* is duly impregnated with the Virtues it communicates, and properly managed, its Extremities at ſometimes points directly *North* and *South*, and thence varies both in the ſame and in different places of the *Globe*, in regular and uniform Figures, towards *Eaſt* and *Weſt*, according to the *Syſtem* of theſe Variations diſcovered by the *Learned and Ingenious* Dr. *Halley*. And very probably, as the common *Horizontal* Needle, is continually varying towards *Eaſt* and *Weſt*, ſo the dipping or inclining Needle is varying up and down, towards or fromwards the *Zenith*, according to the Suſpicions of the *Learned*

*ned* and *Reverend* Mr. *Derham*, and possibly in a regular and uniform *System*, and there may be other beautiful and regular Qualities not yet discovered, in it all these mentioned being found out within less than 500 Years. There is a Ring about *Saturn* which moves differently from his Body that somewhat favours this Supposition of *Interior Orbs*, but I cannot come into the Opinion that this *Annulus* may be some remains of the Ruins of a Crust, that is fall'n in upon the Body of the *Planet*, because this *Ring* appears to be regular and uniform, of an equal breadth quite round, and at an equal distance from the Body of the *Planet*; besides, it is scarcely probable that these *Planets*, which like ours, may be design'd for the Habitation of some sort of *Animals*, shou'd be so ruinous as this Supposition wou'd make that *Planet* to be. If it be true that all the Bodies of the Universe *attract* one another, and if it be very probable from the Benefits of our *Moon* to the *Earth*, that such like and *analogical* Advantages, of raising Tides in the Fluids, reflecting Light in the Night Seasons, and emitting other Influences for Life and Vegetation, acrue to the *Planets* from their *Satellits* and other *Appendages*, then it's very plain that whenever a lesser Body (however figur'd) attends the Motions of, and revolves with a greater,

ter, that that leſſer Body is deſign'd by its *attraction*, and Influences to produce ſome effect, that is the Conſequence of this *Attraction* and theſe Influences. Thus it's plain, our *Moon* was deſign'd to raiſe our *Tides*, and regular Winds, to enlighten our Nights and to diſturb the Motions of our *Earth*, for Purpoſes that poſſibly we may, or may never, come to diſcover; and ſo the *Satellits* of *Jupiter* and *Saturn*, were deſign'd to attract their Fluids, and to enlighten their Nights, or diſorder the Motions of their reſpective *Planets*; or to produce ſome effect conſequent upon Attraction, and I have ſuggeſted before, that the Multitude of the *Satellits* of theſe *Planets* may ſerve in their vaſt diſtance from the *Sun*, to hinder their Fluids (by frequent and various Diſturbances) from freezing; and to enlighten their long tedious Nights, and the greater number of the *Satellits* of *Saturn*, than *Jupiter*, ſeems to favour this Conjecture. Now this *Annulus* may poſſibly ſerve ſome ſuch purpoſe as this, ſince it moves differently from the Body it ſelf. But all theſe are but Conjectures; and as ſuch I leave 'em. It's probable that *Earthquakes*, and *Vulcano*'s, proceed from ſome Motion and Mixture of different Particles within the Body of the *Earth*; for as to a *Central Globe* of Fire, it is not eaſily to be conceiv'd how it can

subsist without Air or Fewel, or without consuming the contiguous Parts of the *Globe*, and if it had either Air or Fewel, it must make a greater Havock, than any History mentions. Besides, that it cannot well consist with these mention'd *interior Orbs*, without confounding their regular Motions: All the Appearances of Nature which seem to require it, may be more naturally solved by the *Fermentation* of different Steams and Vapours, within the Cavity of the *Earth*. These *Vulcano's* and fiery Eruptions, never happen but where Sulphur and Iron are copiously found, which we are certain may produce Heat and Flames when duly mixt and fermented, any where: And it's observable that there are scarcely any Country much annoyed with Earthquakes that have not one of these *fiery Vents*; which shows that these *Vulcano's* are the necessary Consequences, and the *Tunnels* of the fermenting Vapours, in the Bowels of the *Earth*, and not Chimneys to the Central Heat: And this by the way is a bountiful Contrivance in Nature, to lessen and evaporate these tumultuos Steams, which otherwise might make much greater Havock than now they do. Earthquakes and *Vulcano's* in the Earth being the same that Thunder and Lightning are in the Air, and from the same Causes: It is likewise probable that its *Stra-*

*ta*,

*ta*, are not of such Gravities as a regular subsidence according to the Laws of Gravitation of Bodies, wou'd require; which shews it has not been compounded by these Laws. It's certain, that we have fresh Water at any considerable depth, in most Places distant from the *Sea*; which shows how uniformly and equally this so absolutely necessary Fluid has been distributed for the Benefit of the Inhabitants of this Globe; we have from its *Bowels*, all those *Metals* and *Minerals*, with all their varieties, which are of so much use, for the Accommodations of *Life*, and the subservience of *Medicine*; from the depth of the *Sea*, and the *Bowels* of the *Earth*, we have all our natural *Salts*, which do us so great and manifold Services. If any one had but occasion, to look over the variety, beautiful Figures, and Colours of *Shells*, *Petrifactions*, *Ores*, *Minerals*, and *Stones*, and other natural Curiosities, (of which the noblest, and largest Collection, possibly now extant, is to be seen, in the Possession of the *Industrious and Learned* Dr. *Sloan*) he cou'd not but admire the *manifold Wisdom* of the Author of Nature. This were a very large and copious Field, and wou'd afford very *demonstrative* Instances of *Counsel* and *Contrivance*. But I have so many other things to suggest on the Head I am about, that I must content my self with *Generals*.

## Chap. VI.

### *The Proofs for the Being of a God, arising from the Contemplation of the Humane Structure.*

§ XXXIII. Having dwelt so long upon the *inanimate* part of this *System* of things, I come now to consider the *Animal* Kingdom; that *noble* and *manifest Representation* of the *Power* and *Wisdom* of the *Author* of *Nature*. One of *Democritus* or *Des Cartes*'s Disciples, may perhaps undertake to give some faint and imperfect kind of Explication of the *Celestial* Appearances, from their *Principles*, tho' how wretched their accounts of this Matter are, we have in some measure already shewn. But when they come to a *Plant*, or *Animal*, they are perfectly at a loss, they can produce nothing coherent, or of a piece; their *Schemes* then, are like the effects of the casual *concourse* of *Atoms*, an odd inconsistent Mixture of things, that has neither Form, nor Beauty. For ev'ry part of these, is so exactly adapted, to some

wise

wiſe *Deſign*, ev'ry thing is ſo fitted, to its own proper uſe; and theſe Uſes are ſo manifeſt and evident, that they clearly argue, an infinite *Wiſdom*, an exact and exquiſite Knowledge, in the Laws of a Divine *Geometry* and *Harmony* infinitely ſuperior to our low Figures and Numbers, that nothing is ſufficient for, but a *Being* abſolutely *perfect*. I ſhall here, as I did in the *Celeſtial Philoſophy*, give ſome general *Scheme*, of the *Animal Fabrick*, and *Oeconomy*; and ſhall confine my *Speculations*, to the *Humane Structure*, as being the moſt perfect, we are acquainted with, and which being fully underſtood, the reſt will eaſily follow. I ſhall begin with the proceſs of the *Aliment* and the *Circulation* of the Blood.

§ XXXIV. The Meat being groſly divided by the Teeth, and ſoftned by the *Saliva*, is through the *Gullet*, by the Conſtriction of its *Fibres*, thruſt into the *Stomach*; where being ſwell'd and farther ſoftned by the *Succus* of its *Glands*, and the Liquors taken in, by the perpetual Motion of the Coats of the *Stomach*, againſt one another, the *Muſcles* of the *Midriff* and *Abdomen* employed in reſpiration, and poſſibly from other Cauſes, never to be known, its parts are broken, and their intimate Coheſions diſſolv'd. And by this *preſſure* of the ſides of the *Stomach* upon the contain'd *Aliment*, it is

thrust into the *Intestins*; at its entry into which, it is irrigated with the *Bile* and *Sweetbread-juice*, the one to sweeten, the other to dilute the *Chyle*, by the *vermicular* Motion of the *Intestins* (arising from the alternate Action of their *Spiral* and *Longitudinar Fibres*) the *pressure* of the *Midriff* and the *Muscles* of the lower Belly, the grosser parts are deriv'd downward, to be thrust out of the Body, while the finer, are squeez'd into the narrow *Orifices* of the *lacteal* Vessels, which open into these *intestines*; whence in slender Channels they are carried into the *Glands* of the *Mesentery*, receiving first a fine thin *Lymph* from the *Lymphatick* Ducts which dilutes this *Chylous* fluid, and scours its containing Vessels, which from the *Mesenterick Glands* unite in larger Channels, and pass directly into the common *Receptacle* of the *Chyle*, which is a Bason, form'd for it by the Union of these *Lacteal*, and *Lymphatick* Vessels; from thence in one Duct, it ascends into the *Thorax*, and about the Heart sometimes dividing, it immediately unites again, and creeping along the *Gullet*, it passes on to the left *Subclavian* Vein, where in one or two Mouths, it opens into that Vessel, and there mixes with the Blood, and *circulates* with it, which *Circulation* is thus perform'd. The Veins (in a continued Channel, as is

reasonably

reaſonably to be ſuppoſed, with the *Arteries*,) bring the Blood from the Extremities of the Body, and all uniting in two large Veſſels, whoſe ſides diverge, from the *Vena Cava*, *Aſcendens* and *Deſcendens*, which two likewiſe join at their entry into the right Ear of the Heart, which in its *Relaxation* or *Diaſtole*, receives the Blood from them, and in its Conſtriction or *Syſtole*, thruſts it into the right *Ventricle*, which is then in its ſtate of Remiſſion: Which when contracted, drives it through the *Arteria Pulmonalis*, into the *Lungs*; whence it is receiv'd, in an uninterrupted Channel, by the *Vena Pulmonalis*, and is carried into the left *Auricle* of the Heart, then open to receive it; by whoſe Conſtriction, it is diſcharged into the left *Ventricle* then likewiſe dilated, by whoſe contraction it is puſhed into the *Aorta*, which bending a little upwards, ſends forth the *Cervical* and *Axillary Arteries*, the reſt turning down again, forms the deſcending Trunk, and theſe dividing into innumerable leſſer Channels, carry the Blood to the ſeveral parts of the Body, where leaving ſome of it's Particles proper for their uſe; the reſt is ſent into the *Veins*, which are nothing but the returning *Arteries*; and thus the Blood is carried about in a perpetual *Circle*, from the *Arteries* into the *Veins*, and from theſe to

thoſe;

those; and in this *Circulation*, duly perform'd, Life and Health consist.

§ XXXV. As it is plain from what has been said, that it is only the Blood, that is immediately recruited by the *Chyle*, so is it likewise evident from thence, that it is only from the Blood, that all the Expences of living are furnished, and that all the *Secretions* of what kind soever are deriv'd. Now these *Secretions*, are made by the assistance of the *Glands*, and a *Gland*, is an *Organ* consisting of some one or more Turns, Folds, *Convolutions* and Contextures of Vessels, in a proper *Membrane*, for the separation of one Liquor from another. The most conspicuous *Gland* of an Animal, is the *System* of the *Guts*, where the *Lacteals* are the *emissary Vessels* or *separatory Ducts*: The *Mesentery* is the Membrane that keeps them in their natural Situation, and the *Peristaltick Motion*, the several *Convolutions*, with the *Valves* of these long hollow Channels, are the *Mechanical Apparatus*, whereby the Chyle is separated from the Food, and carried into the common *Receptacle*. The *Testicles* when unfolded, give us another plain Conception, of a *Gland*, where the *Artery*, after having sent the greatest part of the Blood, by many little opening Branches, into the nearest Vein, is carried on in a *Cylindrical* Figure, through many

Foldings

Foldings and Plies, conveying through its ſingle *Tube*, the proper Liquor into a common Baſon. There is, no doubt, as great a variety of Structures in the *Glands*, as the different Liquors to be ſeparated are, for ſince the *Arterial* Blood is the common Subject, the Diverſity of the ſeparated Liquors muſt depend on the different *Structures* of theſe *Strainers*. Some, no doubt, are very Simple, ſuch perhaps are the *Glands* of Perſpiration, where a little Tube, jetting out from the Extremity of an *Artery* where it degenerates into a Vein, may be ſufficient to carry off theſe Vapoury Steams, of the Blood; tho' even here, *Anatomiſts* have obſerved Art, Contrivance, and Complication. But the ſtill more complicated, ſeem to conſiſt of a *Membrane*, forming (by the contexture of *Blood*, *Veſſels* and *Nerves*) an oval or round Baſon, for receiving the ſeparated Liquor, and of two or more *Ducts*, for conveying in, and carrying out of this Cavity, the ſeparated Liquor. This Membrane, is as it were a Stay and Baſe, for the Blood Veſſels and Nerves, to keep them in their natural Situation; and to form the Cavity. Here, the Blood Veſſels are interwoven into different Figures, Situations, and Inoſculations, according to the Neceſſity of the ſeparated Liquor. There are other *Glands* again, yet ſtill more complicated, but they

are

are commonly no other, than a Mass of the former, contain'd under one common involving *Membrane*, and having all their *emissary Ducts*, united in one large common Vessel, which may enter into another *Gland*, as an *Artery*; and so a new Separation may be made, from the former separated Liquor. I will not assert any thing positive about the *Mechanical* Explication of the separation of one Liquor from another in an Animal Body. All I have hitherto seen on the Head, being either too general or too precarious: But something like these three Conditions, seems to enter into this Disquisition. 1. The different *Diameter* of the *Orifice* of these *Secretory* Ducts, whereby Particles of a *Diameter*, greater than that of this Duct, are excluded. 2. The different *Angle*, which this Duct makes, with the Trunk of the *Artery*; for it is already demonstrated, that all Fluids press the sides of the containing Vessel, and that in a direction *perpendicular* to these sides; and this is evident in the *pulsation* of the *Arteries*, since it is, to that *pressure*, this *pulsation* is owing. It is likewise evident that the Blood is urg'd forward by the Force of the Heart, so that the Motion of *Secretion* must be compounded of both these Motions. Now tho' this *lateral pressure*, is greater, when the *Velocity* of the *longitudinal* Motion is so, yet

it

it is not in the proportion of this *Velocity*; for this *preſſure* is always ſomewhat even, when the Fluid is at reſt, and is then in *proportion*, to the *Specifick* Gravity of the Fluid, nothing elſe being in this Fluid to produce this *preſſure*, and in a Fluid urg'd by a *Longitudinal* Direction, as the Blood in the *Arteries*, this lateral *preſſure*, is in a compound proportion of both; whence it is evident that if two Particles of equal *Diameters*, but of unequal *ſpecifick* Gravities, arrive with the ſame *Velocity*, at an *Orifice* capable of admitting either of 'em, yet they will not both paſs, becauſe their *Motion* of *Direction* is different: So that this Diverſity in the *Angles*, theſe *Secretory* Ducts make with the *Trunk* of the *Artery*, ſeems altogether neceſſary to account for the poſſible Diverſities of ſecern'd Fluids, ev'n admitting their *Diameters*, and Figures, to be the ſame. For it is not to be doubted, that the Blood is a *Hetrogeneous* Fluid, and contains parts of different *Specifick* Gravities, different Coheſions, and of different Denſities; and the ſeparated Fluid muſt be nearly *Homogeneous* to perform the uniform Functions of Life. 3. The different *Velocities*, with which the Blood arrives, at the *Orifices* of theſe *Secretory Ducts*, for ſince the *Secretions* are made in form of a Fluid, there is no poſſible Reaſon can be aſſign'd, why ſome

some *Animals* of the same Species are of a soft loose Texture, and Union of solid Parts, and why one part of the Body is of a tender, loose, easily separable Texture; others of an harder, firmer, and more close Cohesion, but this different *Velocity* of the Blood, at the *Orifices* of the separatory Ducts. And tho' the Diversity of the *Diameters* of these Ducts, is certainly that which is of greatest *Moment* in this Affair of *Secretion*, yet it is impossible to account, for the *similarity* of the secern'd Fluids from so *Heterogeneous* a Fluid, as the Blood is, from this alone. For suppose, (as my worthy and learned Friend Dr. *Cockburn* has very justly reasoned) the *Diameters* of the Particles of *Urin*, *Gall* and *Semen*, to be as 1, 2, 3. The *Diameters* of the *Secretory* Ducts, of the *Kidneys*, *Liver* and *Testicles*, must be in the same *Proportions*. Now tho' upon this supposition of only different *Diameters*, the Particles of *Gall* and *Semen* cannot be separated in the *Kidneys*, yet the Particles of *Urine* and *Gall* may be separated by the *Excretory* Ducts of the *Testicles*, the *Diameters* of the Particles of the Fluids, being by supposition, less than that of the *Diameter* of the *Excretory* Ducts of the *Testicles*. So that upon this supposition of only different *Diameters*, it is impossible to account, for the *Homogeneity* or *similarity* of the *se-*

*cerned*

*cerned* Liquors: For all the Particles of whatever kind, that are leſs than the *Diameter* of the *Secretory* Duct, muſt be indifferently ſeparated there. *Nutrition* may be perform'd by a *Secretory* Duct, ariſing from the terminating *Artery*, which carries a ſuitable Portion of the Blood, to every part to be nouriſhed, ſo that ev'ry point in the Body, muſt be the *termination* of a *Secretory* Duct; through which a proper part of the Blood is brought. The Blood in its *Circulation*, being carried into the Cavity of the *Skull*, in the Branches of *Carotid* and *Cervical* Arteries, theſe are divided into innumerable *Ramifications*, ſo as to become extremely ſmall: Their laſt Extremities after the manner now deſcribed, form a little *Gland* (all theſe little *Glands* together make the *Cortical* part of the Brain) terminating in two little Veſſels, one for carrying back as a Vein, the groſſer part of the Blood; another as an *Emiſſary* Veſſel to each of theſe *Glands*, diſtributing throughout the whole *Syſtem*, the more pure, refin'd, and ſubtile part of the Blood, (as is ſuppos'd) which is then call'd the *Animal Spirits*. All theſe little *Emiſſaries*, united together at their Origin (the *Cortical* part of the Brain,) make that Subſtance, which is called the *Medullar* part; being a Bundle of very ſmall, thread-like Channels, or Fibres,

Fibres, some of which are carried through their proper Cavities, in the *Skull*, for the use of the *Organs* of Sensation; the rest through the Cavity of the *Spine*, to be distributed at proper places, through the rest of the *System*. It is not impossible but these *Emissary* Vessels of the small *Glands*, whereof the *Cortical* part of the Brain consists, may contain a Liquor, and that this Liquor may be the more refin'd, and subtile part of the Blood; especially if we reflect that *Nature* does nothing in vain, and that these *Glands* differing scarcely at all from those others, which we certainly know separate proper Liquors, but in the length of their *Emissary* Vessels (the necessity of which in the present Case is self-evident) and that the Blood Vessels, being sent in such Numbers into the Brain, and in a much greater proportion, than to any other part of like Dimension, and being there form'd into the mentioned *Glands*, and these *Glands* sending out these small *Emissary* Vessels, over the whole *System*. It is not impossible I say, that these may carry a suitable Liquor. For 1. almost the whole Mass of Blood, in a little time is brought to this *Cortical* part of the Brain: (The most subtile, most spirituous, lightest, and most moveable part of the Blood, ascending by the *Carotid* and *Cervical* Arteries; the grosser, heavier and least

leaſt active, deſcending toward the lower parts, by reaſon of the Situation; and the greater *ſpecifick* Gravity of theſe laſt parts of the Blood.) 2. In the *Medullar* part of the Brain is often found on Diſſection, a thin, whey-like ſubſtance, which Fire hardly thickens. 3. The Nerves, are equally diſtributed all over the Body, are abſolutely neceſſary toward all Motion, Natural and Voluntary, and 4. They are the *ſpecifick Organs* of Senſibility. All which ſeem to imply that they are the containing Channels, of ſome Liquor; and then poſſibly this Liquor may be ſomething a kin, or *Analogous* to thoſe Spirits we gather from animal Subſtances, by Heat in an *Alembick*: Such as are Spirits of Sal *Armoniack*, *Hartſhorn*, *raw Silk*, or *Humane Skulls*; and what renders this Conjecture more probable, is the not altogether diſſimilar *Apparatus* in forming theſe *animal Spirits* in the Brain, from that of drawing thoſe others, in an *Alembick* by Fire; and the wonderful preſent Efficacy, theſe laſt have on the firſt; and that both are equally unalterable, by Heat and incapable of Burning. But then if we conſider on the other Hand, that theſe *nervous Fibres* ſerve equally, and adminiſter unto Nutrition, local Motion, and Senſation; this laſt Function ſeems intirely oppoſite to the Nature of a Fluid, neceſſarily acting in the

other two Functions from within to without, and in this laſt from without to within. Add to this, that this nervous Fluid has never been diſcovered in live Animals by the Senſes however aſſiſted: Nor it's neceſſity evicted, by any cogent Experiment; and that *Leuvenhoecks* Experiments makes the Fibres, or the laſt Channels of this Fluid, ſo infinitely ſlender, ſmall, and ſpongy, that conſidering the reſiſtances from the ſides of the Veſſel, in ſmall tubes: It ſeems abſolutely impoſſible, any Fluid (ſuch as we have any *Idea* of) cou'd move with Velocity to anſwer the Appearances; ſo that after all, it ſeems pretty difficult to come to any certain Concluſion on either ſide. But either the Fibres, contain a pretty conſiſtent Fluid whereof they are conſtantly full, and then the leaſt drop forced into the one Extremity, will drive out as much at the other, and that inſtantaneouſly; or theſe *Fibres* are ſolid, and not pervious and ſome infinitely ſubtle Spirit pervades them, with as much Facility as it wou'd the moſt *pervious* Tubes; either of which Suppoſitions will account for the Appearances, in a groſs and general manner, which is all we can pretend to in ſuch conjectural Caſes. By the Motion of the *Heart*, through the *Emulgent* Branches, the Blood is brought to the *Kidneys*, and is there freed of its *Serum*, by their little

little *Glands*, and is receiv'd into the ſmall *Excretory* Ducts of theſe *Glands*, to be carried into the *Pelvis*, and thence by proper *Tubes* into the *Bladder*. Much after the ſame manner, are their proper Fluids ſeparated from the Blood in the *Liver*, *Sweetbread*, *Teſticles*, and the other *Conglobat* and *Conglomerate Glands* of the Body, ſo that it is needleſs to inſiſt on theſe.

§ XXXVI. The *Lungs* are compos'd of an infinite number of little *Lobes*, of different Figures, and Magnitudes, but ſo join'd as to leave but ſmall Vacuities between 'em. Each *Lobe* conſiſts of an infinity of ſmall *ſpherical* or *oval Verſicles*, form'd by the Coats of the ſmall Branches of the *Trachea*; ſo that they may be conſidered (when blown up) as ſo many fine *Tubes* ending in little hollow *Spheres* or *Spheroids*; upon the ſides of the *Veſicles*, the Blood Veſſels in a fine *Net-work* are ſpread. Now before the *fœtus* is brought to Light, theſe *Veſicles* lie flat upon one another, and by their *preſſure* upon the Blood Veſſels, hinder its progreſs thro' them; but as ſoon as this *fœtus* enjoys the benefit of the Air, by its weight and *elaſtick* Force, this Air ruſhes in thro' the Pipes of the *Trachea* into theſe *Veſicles*, and blows 'em up, whereby they ſtand erect upon the *Trunks* of theſe little *Wind-pipes*, and give a free paſſage to the Blood

through these Vessels, spread upon their sides. And when by the weight of the *Thorax*, and the Action of the Muscles thereof, with those of the *Abdomen*, and *Midriff*, this *elastick* Fluid is thrust out of the *Vesicles*, thro' the *Trachea* in *Expiration*; these *Vesicles* pressing against one another, and the *elastick* Fluid acting upon the sides of them, and consequently, on the Blood Vessels spread thereon, separate the *Globules* of the Blood, which had Room and Liberty to unite in the wider Channels of the *Veins*; and this separation of these *Globules* of the Blood, from one to another, renders it more capable to *circulate*, in the more narrow passages of the *Capillary* Vessels, divides and subtilises the grosser parts of the *Chyle*, gives a Scarlet Colour, Fluidity and *Energy*, to the gross, grumous and stagnated Venous Blood. But, if I be not very much mistaken, there is still another use of this natural *Function* behind, and that is to form these *elastick Globules* of which the Blood principally consists. It is Matter of Fact and Observation, that the Blood consists of a *Lymph*, which is the common *Vehicle*, several *Salts*, *Ramenta* of a thick consistence, made up of small Particles of carneous and vegetable Fibres from the Food, (which is probably the unform'd part of the *Chyle*, and Aliment) and these red *Globules*, of which we are now speaking;

king; but ſometimes they are of different Colours, as *White*, *Blew* and *Purple*; theſe any Body may diſcover with an ordinary *Microſcope*. Now it's certain, that theſe *Globules* may be burſt, as in obſtructions; or may be all exhauſted, as in violent *Hæmorrhages*, and yet be all recovered and recruited again; wherefore it is of neceſſity, that theſe *Globules* muſt be form'd ſomewhere in the Body from the *Chyle*. And ſince it's certain that they are not ſolid *Particles*, both by ocular inſpection and touch, and by the neceſſity they are under to change their Figures into oblong *Spheriods*, in the *capillary* Veſſels, as alſo from their Colour, and that *Acids* do actually deſtroy their Figures, and coagulate theſe *Globules*; it is not improbable, they may be little bubles, blown from the viſcid part of the *Chyle*, by the force of ſome more ſubtile *Elaſtick Aura*. Now no Place in the Body, but the *Lungs*, can ſo conveniently afford this *elaſtick* Fluid; and this may be the reaſon why the *Chyle* enters into the *Veins*; and theſe too only, which are juſt returning immediately to the Heart, to be ſent into the Lungs. For ſince in our groſs *Element* of Air, there is conſtantly lodged, a finer *elaſtick* Fluid, which is the principal Agent, in all the ſubtile Effects commonly aſcrib'd to the other, tho' the groſſer *Element* can-

not, yet this finer Fluid, by that vast Force used in *Expiration*, may be thrust in thro' the sides of these *Vesicles*, to the Blood Vessels; and seeing these Blood *Globules* must be generated somewhere, and since there is no part in the Body, this subtile *elastick* Fluid can so conveniently be squeez'd with sufficient force, to get through the sides of the Blood Vessels, but in the *Lungs*; it seems not unlikely, that these *Globules* are form'd there after this manner: The *viscous* part of the *Chyle* being by the shortest and safest course possible, brought into the returning part of the Blood, is sent from the right *Ventricle* of the Heart to the *Lungs*, and is spread upon the sides of the *Vesicles* thereof, in little fine *Tubes*, this fine *elastick* Fluid being squeez'd, in the Act of Expiration, through a *Pore*, continued through the *Vesicle* of the *Lungs*, and the side of the Blood Vessels, is forc'd into the *viscous* part of the *Chyle*, which is running by in the *Serum*, and by its *perpendicular pressure* upon the sides of that Cavity it forms, produces a small little *buble*, of a certain magnitude, and thickness of Shell, from whence it has its Colour, and by the force of the succeeding Fluid, this little *buble* is broken off from the *Pore*, and carried along the *Artery*, and the *Cohesion* of the parts of the Shell of this *buble*, being greater than

than the force from without, whereby the thin *Serum* acts upon it, it is preserv'd in its figure in all the various Motions of the compound Fluid of the Blood; and if it happen that these little *bubles* shou'd be burst, (as they most certainly are by a thousand Causes) when ever they come to the *Lungs*, they are new-form'd again, whereby the *circulation* is rendred constant and uniform. For shou'd these *Globules* be all destroyed, there must of necessity arise a general Obstruction in all the *Capillary Arteries*. The manner of these Production of the little *bubles*, in the Blood by the *elastick* Fluid, forc'd through the sides of the *Vesicles*, and Blood Vessels in the *Lungs*, is so obvious, that I shall insist no farther upon it, since every body may see an Instance of the same Nature, in mixing Oil with Vinegar, the Substance of which Mixture, when view'd, but with an ordinary *Microscope*, appears to be nothing but an *infinity* of such like little *bubles*, form'd by the immission of the Air, and Vinegar, into little Shells of Oil. But from this Principle, some of the despair'd of Appearances, in the *Animal Oeconomy*, may be made easy; and some difficulties about the Causes of Diseases, and the manner of the Operation of *Medicines* vanish. And this makes it look the more like truth, Nature being frugal in her Principles, but

various in the Effects thence arising. But it being both foreign to my Design, and unfit for the Limits I have prescrib'd to my self, to deduce *Corollaries* arising from a Conjecture only: I shall therefore proceed to represent some others of the Animal *Organs* and *Functions*, in the best manner I am able.

§ XXXVII. A *Muscle* is a bundle of *Vesicular* Threads, or of solid *Filaments*, involved in one common *Membrane*, one of whose Extremities is fastned to an Immoveable, the other to a moveable part of the Body; which by the inflation of the *Vesicles*, or swelling and hardening of these *Filaments*, are brought nearer one another and so become the proper *Organs* of Motion. When a *Muscle* by boyling, washing, and cleansing, is duly prepar'd the Texture of these *Vesicular* Threads, or solid Filaments become more evident and perspicuous. If the last Fibres of *Muscles* be *Vesicular*, then probably they may not be unlike a string of *hollow Beads*, and may be originally hollow Tubes, straitly ty'd together, by transverse *Filaments*, so as to form these little *Bladders*; with which small Branches of Blood Vessels are so interwoven, as that the Mouth of a little Artery, and Nerve, gapes into the Cavity of these *Vesicles*: Both which are so absolutely necessary to the Action of a *Mus-*

*cle*,

*cle*, that either being tyed or cut, at the entry of it, no Action or Motion can enſue.

If *Muſcular Fibrils*, be *Vaſcular*, then we may reaſonably ſuppoſe all the *Carneous* Fibres, which are neceſſarily requir'd for Motion, to be *Veſicular*, after the manner I have now deſcribed them; and that the *Nervous Fibres*; are *Cylindrical Tubes*, for conveying the Nervous Juices. The two Extremities of the *Muſcle* which are called *Tendinous*, were generally thought, to be the ends of the *Carneous* Fibres more cloſely compacted, ſo as to admit but few Blood Veſſels or Nervous Channels. But Mr. *Lenwenhoeck*, by his latter Obſervations on them, ſeems to think them of a different Subſtance from, and to be diſcontinued with, the *Belly* or fleſhy part of the *Muſcle*. If the *Muſcular Fibrils* be Vaſcular (as I have ſaid) then the uſe of their *Veſcular Cells*, may be for receiving the *Arterial* and *Nervous* Juices, that by their Action upon one another, they may be ſwell'd ſome how, ſo as to ſhorten the Length of every *Fibril*, and conſequently to bring the Extremities of the *Muſcle* near one another, which is the proper Action of the *Muſcle*. But whether the ſwelling of the *Veſicles* be owing to an *Exploſion*; to an inſtanteous *Fermentation*; to the greater *Attraction* of the Nervous Fluid

on

on the Blood Globules, than those have upon one another; or to the mere *Mechanical* Action and Pressure, of the Nervous Juice on the arterial Blood already filling the *Vesicule*. Or lastly, whether the *Fibrils* are not in themselves solid, (and not Tubular Filaments,) contracted by a subtile Spirit pervading their solid Parts, whose *Law* and *Action*, is, or is never to be determin'd, I will not take upon me to decide. But if I conjecture right, the Nature of *Life*, *Light*, and *Animal Motion*, will be an eternal Reproach, to *Mechanism* and Humane Invention. The surest Method to arrive at any certainty, in such intricate and obscure Subjects, as some of those Animal *Functions* are, is to go no further than *Anatomy* and *Ocular* Inspection will direct us; and since it is not as yet positively Demonstrated, whether the *Animal Spirits*, be a Fluid contain'd in the *Nervous* and *Membranous* Fibrils, as hollow Tubes, or if they are only a *subtile Spirit* or *Aura* perwading these, as solid Filaments. Nor whether the last and smallest Muscular Fibres be *Vesicular*, or not, I cannot see sufficient materials, to found any just Explication of this Animal Function, upon.

§ XXXVIII. The Fluids of the Body are principally propell'd, by the Action of the Heart, and the *elastick* Force of the *Fibres* of

of the containing Veſſels. Now the Heart is a *Muſcle*, like other *Muſcles*, conſiſting of ſeveral Orders of fleſhy *Fibres*, of different Directions, it has two little *Ears* and as many *Ventricles*, which are Cavities for receiving or holding the Blood, as it comes from the ſeveral Veſſels, or is to be driven to different Places. The *Fibres* of this *Muſcle*, act as thoſe of other *Muſcles* may be ſuppos'd to do, for by the winding and ſpiral Direction of its ſeveral Orders of *Fibres*, the Cavities of the *Ears* and *Ventricles* are leſſen'd or conſtring'd. And it is obſervable that all the *Muſcular Fibres* of the Coats of the Veſſels, act after a different manner from the Nervous or *Membranous* Coats, the firſt ſeem to act by the aſſiſtance of ſome foreign Fluid, *Spirit*, or Principle. But the *Membranous* Coats, meerly by their own *Elaſticity*, being ſtretch'd firſt by external Violence. Thus the ſides of all *Membranes* are bent or preſs'd outward by ſome included Fluid, but reſtore themſelves by their own natural Elaſticity; whereas whenever a Coat conſiſts of *Fibres* of whatever kind, excepting thoſe for *Senſation* or *Nutrition*, it is a ſure *Indication* that this Coat acts as a *Muſcle*; for Nature does nothing in vain, and wou'd never have diſtinguiſh'd a Coat into *Fibres*, but for *Muſcular* Action, when a continued *Membranous*,

*nous*, or *Tendinous* one, is more capable of acting by its own *Elasticity*. So that the Nature of the Coats, and of their constituent *Fibres*, of the Channels, being known, together with the Range and Direction of these *Fibres*, it is easy to know the manner of their operating upon the included Fluid. The Coats of the *Gullet* are three, the outermost *Membranous*, the second fleshy and *Muscular*, turning obliquely from the uppermost end of the *Oesophagus* to the *Stomach*; the third, is tendinous and *muscular*, of white slender *Fibres* diversely interwoven. The *Stomach* has four Coats, the innermost is Carpet-like, of white short tendinous *Fibres* standing *perpendicular* upon the next Coat, which is *nervous* and extremely sensible; the third is fleshy and *Muscular*, of straight and circular *Fibres*; the fourth *Membranous* from the *Peritonæum*. The *Guts* consist of three Coats, the innermost is of the same nature with that of the innermost of the *Stomach*, the second is of two Orders of *Muscular Fibres*, *Longitudinal* and *Spiral*, the third is common and *membranous*, arising likewise from the *Peritonæum*. The *Nerves*, as I have before said, are a bundle of fine, small, and slender *Pipes*, or Threads, wherein the Animal Spirits, or something Analogous to what is called by that Name, are treasur'd up for the Expences of Motion and

*Sensa-*

*Senſation*; they ariſe from the *Glands* of the *cineritious* part of the Brain, and are terminated in all the points of the Body; ten pair deſcend immediately through proper Holes of the *Skull*, and ſerve the adjacent Parts, and particularly the *Organs* of four of the Senſes; the reſt in a large bundle, are let down by the Cavity of the *Vertebræ*, and at fit Places are ſent forth to actuate the ſeveral inferior parts of the Body. The *Arteries* have three Coats, the outermoſt is a fine Web of *Nerves*, and Blood Veſſels, for the nouriſhment of theſe other Coats, and for the *Muſcular Action* of the intermediate one, which is made up of ſeveral *ſtrata* of *Spiral Muſcular Fibres*, according to the bigneſs of the *Artery*. The third is a cloſe tranſparent *Membrane* very ſtrong and compact, to keep in the Blood which otherwiſe upon the dilatation of the *Artery*, wou'd tear the *Muſcular Fibres* aſunder. The *Veins* have the ſame Coats with the *Arteries*, only the *Muſcular Spiral Fibres* are thinner, becauſe of the leſſer force of the Blood againſt the ſides of the diverging *Veins*, than thoſe of the converging *Arteries*. From this general account of the ſtructure of the *Veſſels*, their Actions upon the incloſed Fluid may be eaſily underſtood, the ſhort erected *Fibres* ſerve for the attrition of the *Aliment*, and for ſtraitning the Cavity of the *Guts*

and

and *Stomach*; the *oblique Fibres*, which make but few turns serve to propagate gently the included Fluid, the *Longitudinal* ones to move the Vessel, and the included Fluid, up or down in a direction *parallel* to its length, by encreasing this dimension and thereby lessening the other, *i. e.* the transverse *Diameter*; the *Spiral* ones by squeezing it transversely, and so encreasing it in length or lessening it in breadth. Thus the Blood being pusht by the contraction of the Heart into the *Arteries*, distends their Coats along their whole length, 'till the force of the natural *Elasticity* of the *Membranous* Coat, be equal to the force of this Impulse; then that *Elasticity* of this Coat beginning to act, at the same time the *nervous* Juice, or Spirit is deriv'd through the *Nerves* by this dilatation of the small *Arteries*, among the *Originating Nerves* in the Brain, and so brings the *Muscular Fibres* into Action. And both these Forces acting at once, propel the Blood in a continued Stream, through the uninterrupted Channels of the *Veins* and *Arteries*. And the impulse of the Heart, propagated only by the *Membranous* Coat, is that which when felt, is call'd a *Pulse* or *Pulsation* of the *Artery*.

§ XXXIX. All *Sensation* is perform'd by the immediate Action of the finer and more fluid parts of Bodies, upon the *Organs* of Sense;

Senſe; the Impulſe communicated by theſe ſubtile parts of Bodies, upon the *Organs* fitly diſpoſed, is through them tranſmitted to the *Nerves*, appropriated and contriv'd for ſuch a Senſe, and through them to the Brain. Thus in *Viſion*, the *Light* reflected from the Surfaces of Bodies, is tranſmitted thro' the *Humours* of the Eye, and congregated upon the *Retina*, in the ſame manner it was reflected from the Body, and thereby an Impulſe modified after a certain manner, ſtrikes the *Filaments* of the *Optick Nerves*, which convey this Impulſe to the Brain. In *Hearing*, the Sound after diverſe Modifications, in its paſſage through the *Meatus Auditorius*, ſtrikes on the *tympanum*, which moving the Bones of the Barrel, and they the incloſed Air of the *Labyrinth*, the *Auditory Nerves* there, are mov'd, after the ſame manner they wou'd have been, had the common Air acted upon them, with the Advantage of a better qualified and gentler Impulſe than they cou'd have had otherwiſe. In *Smelling*, *Taſting*, and *Touching*, the *Effluvia* and more ſubtile parts of Bodies, act immediately upon the *Nerves* themſelves, and they communicate this Action to the Brain: So that in ſome manner, all *Senſation* is nothing but *Touching*, ſeveral ways diverſified. *Generation* is nothing but *Accretion*, for it is beyond all doubt, that all

all *Generation* is from a preceding little *Animal* lodged in the Male. I have demonstrated the *Mechanical* production of *Animals*, to be impossible and unconceivable; there is nothing in an *Animal* but an *infinity* of branching and winding Channels, and their contain'd Fluids, and no Disposition or Arrangement of either, can produce an *Animal*, since all the parts must be form'd together, in order to make a complete *Animalcul*; for it is not in Animals, as in Houses, or other humane Performances, where the parts can subsist separately and be fram'd one after another; but towards an Animal, the whole *integral* parts at least, must have been form'd at once: Since we are very sensible there is not one *noble* Part, that an Animal can be without, but with the immediate danger of the whole Compound. And to have the *Animal* compleat and perfect in its kind, there is not a single Vessel, or *Organ*, how inconsiderable soever, that must not have been compleatly formed and fitted up, all and sundry, at one and the same instant of time, since the Circulation of the Fluids, and the natural Functions of the whole, do in a higher or lower degree, depend on the Integrity and Perfection of each single part. We find some little *bubles*, or Blood *Globules*, may be form'd out of the *Chyle* in the

the Veſſels, and one kind of Liquor may be ſeparated from another, out of the Blood in the *Glands*, and theſe are all the Productions an *Animal* is capable of, which can never reach to that wonderful Number, and Diſpoſition of parts, an *Animal* conſiſts of. Now, ſince there is no neceſſity to think *God Almighty* is confin'd to a new Creation, in ev'ry *Generation* of an *Animal*, and that theſe *Animals* themſelves are conſpicuous in all Male Seeds hitherto examin'd, it is plain that they muſt have been all created at once; and lodg'd in the Loyns of the Original pairs of all the *Species* of *Animals*. Likewiſe the Fluids, if they did not move in the Channels of theſe ſmall *Animals*, wou'd corrupt and deſtroy their containing Veſſels. It's evident then that they muſt *circulate* after a manner proper to themſelves; tho' doubtleſs the *Velocity* of their Motions is perfectly accommodated to the ſmallneſs of their *Bulk*, and the ſlenderneſs of their ſolid parts; we ſee an Image of this ſlow and low kind of Life in *Swallows*, *Inſects*, *Vipers*, and other *Reptiles* in the Winter, and in almoſt all younger *Species* of Animals, and even in adult Animals of the rational kind, a Nervous Diſtemper has continued them long alive, in a kind of a Lethargick Drowſineſs without Food or Motion, and without the common Expences of Life.

But since these Fluids cannot move, without some small insensible *Evacuations* and *Secretions*, this Loss must be repair'd some way or other. Wherefore, it is not improbable they may lurk somewhere in the Male, in some proper Place, 'till they be fit to be carried off in the soft and tender Fluid of the *Semen*, to be afterwards lodg'd in the Female; where they are fitted with Accommodations, suited to this Degree of Growth and Perfection, 'till they arrive to the next Period of their Lives; *viz.* to bear the *Light* and the *Air*. We are certain that the *Seeds* of *Plants* are nothing but little *Plants*, perfectly form'd, with Branches and Leaves duly folded up, and involv'd in *Membranes*, or surrounded with *Walls* proper to defend them in this tender Estate, from external Injuries; that the manner of the *Generation* of *Vegetables*, is perfectly *Analogous* and Consonant (as far as their different Natures and Circumstances will permit) to this proposed manner of the *Generation* of Animals. And that *Vegetation* is only the unfolding and extending of these Branches and Leaves, by the Force of Juices rais'd by Heat, in the slender *Tubes* of the *Plant*. We know that the Eggs of *Animals* are only an *Uterus* for a little *Animal*, furnished with proper Food, and senc'd from external Injuries; and we know likewise that

that all the Effects of *incubation*, is supplying a fit degree of Heat and Warmth, to make the congeal'd Fluids flow, and more easily pass into the nourishing Channels of the included *Animalcul*; and the Heat of the *Sun* or of our *Culinary* Fires, when duly adjusted, produce the same very Effects with that of the *Females*. We are sure, that all the several *Transformations* of *Insects* and other *Animals*, are nothing but the *Expansion* of their parts, and the breaking of the *Membranes* that folded 'em up, by the Augmentation of these parts; that all the several Figures and Shapes they put on, are owing to the several *Membranes* they are involv'd in. Now were there no other Argument, but the *Analogy* between the manner of the *Generation* and *Transformations* of these lower, and of the more noble *Animals*, it were sufficient to perswade any one, who considers the simplicity and uniformity of Nature in all her Works. But this, with these already mentioned, make it highly probable that we are all deriv'd from one *Seed*, and were once all actually in the Loyns of our first Parent, and have been ever since, growing to our present Estate.

§ XL. From this general view of the *Structure* of the parts, and of the manner how the *Animal Functions* are perform'd, ev'ry body may see how *wonderfully we are*

*made*, how wiſely our ſeveral parts are fitted for their uſes; how juſtly our Fluids are contriv'd and diſpos'd, to make theſe uninterrupted *Circulations* wherein Life conſiſts; how ſimple, and yet how ſufficient, the Cauſes of all thoſe various Motions, (which we are in ſome manner able to diſcover) the *Animal* performs, are. It is impoſſible duly to conſider theſe things without being rapt into admiration of the infinite *Wiſdom* of the *Divine Architect*, and contemning the arrogant Pretences of the *World* and *Animal Wrights*, and much more the Productions of Chance or juſtling *Atoms*; for ſince even *Mechaniſm*, aſſiſted by ſome kind of *Art* and *Contrivance*, does ſo miſerably blunder in the Undertakings of this Nature (as we may ſee in all the *Schemes* of the *Projectors* upon theſe Heads) we may be aſſured *blind Chance* and *Jumble* cou'd never produce ſo beautiful ſimple and uniform Effects. Cou'd any of our *mechanical* Undertakers, with all their ſkill and cunning, make but an *Inſect* or a *Plant*, with the ſame Faculties and Qualities that Nature does; we ſhou'd begin to hearken to 'em. But they are ſo far from that, that the moſt exact and nice Performances of *Art*, come ſo far ſhort of the dead *Organs* of *Animals*, or the *inanimate* Productions of Nature, that a weak Eye may diſcover the

vaſt

vaſt Difference. Wherefore of unavoidable Neceſſity, *He that form'd the Eye muſt himſelf ſee, and he that made the Ear muſt himſelf hear, and he that endu'd Man with Wiſdom muſt himſelf underſtand*; and he that contriv'd ſo wonderfully and wiſely, and form'd ſo juſtly and exactly, all things both animate and inanimate, muſt needs *Himſelf be.*

But I proceed to make ſome reflections upon the particular Inſtances of *Counſel* and *Wiſdom* in the *Animal* Fabrick.

§ XLI. The Skin with its parts is what offers it ſelf firſt; the *Scarfskin* being uppermoſt, is compos'd of ſeveral Lays of ſmall *Scales*, which cover one another more or leſs, or lie thicker, according as it is thicker in one part of the Body than another; between theſe *Scales* the *Excretory* Ducts of the *Miliary Glands* of the true Skin open. *Lewenhoeck* reckons that about one Cuticular *Scale*, 500 ſuch Ducts may lie, and that a Grain of Sand will cover 250 of theſe *Scales*, ſo that one grain of Sand will cover 125000 *Orifices* of theſe *Excretory* Ducts. Now what a prodigious Number of ſuch *Glands* muſt there be on the Surface of the whole Body! Into ev'ry one of theſe *Glands* an *Artery*, *Vein* and *Nerve* do enter; ſo that we may gueſs how prodigious the Number of *Organs* in an Animal Body muſt be, from

these that are visible to the Eye assisted with an ordinary *Microscope.* These *Glands* secern the Sweat and insensible Perspiration. And of necessity they must be many, since *Sanctorius* observes, that through them fifteen Ounces weight of a Fluid passes in 24 Hours. Next under the *Scarfskin* are the *Papillæ Pyramidales*, infinite likewise in Number; they are the Extremities of the *Nerves* of the *Skin*, and serve more immediately for the Sense of *Feeling*, to convey the Impulse receiv'd, along the *Nerves* to the *Brain.* About these, the *Nerves* and other Vessels make a fine *Web*, all cover'd over with a mucous Substance, to moisten these *Papillæ Pyramidales*; and then under this the *Miliary Glands* themselves are plac'd, protruding their *Secretory* Ducts, to the Surface of the *Scarfskin*; upon which there are many *parallel* Lines, and these intersected by others, and in each intersection a Hair is planted. In the *Summer* the Skin is thinner and softer, in *Winter* more compact and hard, by reason of the heat and cold of these different Seasons. The *Scales* of which the *Scarfskin* is compos'd are design'd to fence the *Orifices* of the *Secretory* Ducts of the *Miliary Glands*, and to hinder Objects from making too painful and exquisite an Impression on the *Nerves*, and to skreen them from external Injuries; the Skin it self is design'd to wrap up the whole

whole Body, to ſuſtain and to keep the *Papillæ Pyramidales* in their Places, and the *Miliary Glands* from being diſordered, to receive the Impreſſions of external Objects, and to be the *Organ* of the Senſe of *Touching* and *Feeling*. Now what can be more wonderfully contriv'd than this exterior part? If the *Papillæ Piramidales* or the *Miliary Glands* had been few and large, then the Intervals had been without any Senſe of *Feeling*, and ſo might have been deſtroy'd without our Knowledge, to the danger of the whole; and theſe *Intervals* had not been freed from the noxious parts, which are here thrown out of the Body by theſe *Glands*; but by their infinite Number, ev'ry point and *Atom* of the *Animal* Body is taken care of. But that which is yet moſt wonderful, is the apt proportioning this Senſe of *Feeling*, to the Actions and Impulſes of the Bodies among which we live. For had our Senſe of *Feeling* been ten or twenty times as exquiſite as it is, then we ſhou'd have been in perpetual Torment, ev'ry Hair had been a Dagger, the touch of a Feather, or of the Wing of a *Fly*, had made us cry out, we ſhou'd not have dar'd to have approach'd our Cloaths or our Beds; in ſhort, we had liv'd in perpetual Miſery; and had it been as many times duller, or more *callous* than it is, our tendereſt parts

had been as insensible as our Hairs or Nails, and might have been torn away or consum'd, without our Knowledge or Concern. Whereas by this nice adjustment of the Sense of *Feeling* to the Impulses and Actions of Bodies round us, we can live in indolence from the Disturbance of the *effluvia*, and Actions of little Bodies that are necessarily in Motion; and we feel sensibly enough, to hinder us from hazarding the Ruin of our Fabrick. And universally indeed in all *Animals* whatsoever, this Sense is adapted to the Circumstances wherein they live, which is a notable Instance of *Council* and *Design* in the formation of the Parts. And it is worth noticing, that this Sense of *Feeling* is rendred more exquisite and sensible, or more dull and imperceptible, as it is more or less used; for it is highly probable, that the *Scales* which compose the *Scarfskin*, and guard the *Organs* of this Sense from being violated, do arise from the *pressure* of touching Bodies upon the Mouths of the *Superficial* Vessels at different times, by which some drops of a viscid Fluid is forc'd out, which there drying and hardning, become a small *Scale*; and therefore the oftner the Mouths of these Vessels are press'd upon, or the oftner we use the *Organs* of *Touching*, the more of these *Scales* are form'd, and the Skin becomes the thicker, and so a *callousness*

*louſneſs* grows upon it. And conſequently, the more moderately we uſe the Pleaſures of Senſe the more lively and ſenſible they are, and the more immoderately we uſe theſe Pleaſures, the leſs they are ſo; which is a wonderful wiſe Contrivance of the *Author* of *Nature*; for were it otherwiſe, ſo diſtracted is the moſt part of Mankind, that they wou'd certainly deſtroy themſelves, ſince we ſee where there is both Sin and preſent Puniſhment, they are not kept from Exceſſes that way.

§ XLII. Having already ſhewn the wonderful yet ſimple ſtructure of the *Muſcles*, I have little more to add upon that Head. For tho' ev'ry ſingle *Muſcle*, of which there are about 446 in a Humane Body, either in its *Figure*, *Situation* or *Inſertion*, has ſomething that ſpeaks *Deſign* and *Council*; yet ſeeing *Borelli* has written a whole Book to ſhew this, and to inſtance in all the Particulars, were to tranſcribe it, or to write a whole *Syſtem* of *Myologie*, I ſhall refer my Reader for his full Satisfaction in this Affair, to that learned and ſurpriſing Book *De motu Animalium*, and ſhall only ſuggeſt a few Inſtances. 1. Then the manner of the Diſpoſition of the *Muſcles* of the *Fingers* and *Toes*, is admirable. We know that for the uſes of Life, theſe

*Muſcles*

*Muſcles* were to be ſtrong and large, that that they might be ſufficient for the various, and forceable Motions of theſe *Organs*; now had they been ſituated near or about theſe Parts, they wou'd have altogether diſturb'd their Motions, and made theſe Places ſoft and ſpongy, and conſequently unfit for graſping and going: And to avoid this, the *Infinitely wiſe Author of Nature*, has plac'd them at a conſiderable diſtance from theſe *Organs*; and that ev'n there, they might not in bending the *Arm* or *Leg*, riſe up and fill thoſe Places with their *Bodies* or *Tendons*, he has ty'd them to the Bones by *Annular Ligaments*; and alſo that one *Tendon* might not be interrupted in its Courſe by another, he has ſlit ſome, that others might paſs through them undiſturb'd. This is ſuch a wonderful Inſtance of Wiſdom and Deſign, that none can paſs it over without Admiration. 2. It is very obſervable that in *Muſcular* Motion the Expenſe of *Animal Spirits*, is not in Proportion to the Labour the *Animal* is at. Mr. *Bernoulli* in that *curious* Meditation about *Muſcular* Motion, printed in the *Acta Lipſiæ* 1694, has demonſtrated (for whatever be in his *Theory*, yet there is certainty enough in his general Conſtruction of a Muſcle, to bear out this Obſervation) that the Expenſes of *Animal Spirits*, are in a much leſs Proportion,

tion, than the elevated Weights; for ſuppoſing the *Animal Spirits* expended, to be as 8, then a Weight four times as great, as when they are but as 5, may be lifted. So that when the *Animal Spirits* are but as 5 to 8, the Weight ſuſtain'd by 'em ſhall be as 1 to 4. And the like of the other Proportions of the *Animal Spirits*; eſpecially the Difference becomes moſt ſenſible between theſe *Animal Spirits* and the ſuſtain'd Weights, when theſe *Spirits* are expanded in greateſt Quantities. Now what a wonderful wiſe Contrivance and *Compendium* of Nature is this? Here in great Labour, the *Animal Spirits* which are the Life of the Blood, *which is it ſelf the Life of the Animal*, are ſav'd as much as is poſſible; ſo that a Man who is obliged to hard Labour, is not reduc'd to the neceſſity of having twice or four times as much Victuals, as one that is under no neceſſity to Work. We all know that the Spirits are the moſt precious things in all the *Animal Body*, by which we move, and our Blood *circulates*, *i. e.* we live; by which all the Pleaſures of Life are reliſhed, and all *Senſation* perform'd, by which we have that Livelineſs and Agility, that Chearfulneſs and Tranquility, that actuates all our Enjoyments; and without which, we are languid, and dull, unactive, and thoughtleſs. Now this,

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so necessary and useful a Substance, was to be sav'd by all means possible, and agreeable to the necessities of Life, and we see the wise Author of Nature, has taken wonderful Care, that no Expenses shou'd be made therein that cou'd be avoided. 3. What a strange variety of Motions are our *Organs* capable of? There is no possible one, that might be useful to us that we want, and how wonderfully is the whole *Machin* adjusted? For our erect Motion, the Center of Gravity is so dispos'd, as to fall, by a Line drawn from it to the Center of the *Earth*, always in some part of the *parallelogram* form'd by the outer sides of our Feet, and two Lines drawn by our Toes and Heels, by which means we are kept from tumbling: And if at any time we chance to throw this Line without that Space, and so be in hazard of falling, our Arms, and the various Motions of our Head, and Breast, immediately bring it back within that Space. Those *Animals* that are design'd for flying or swimming on the Surface of the Water, have all their strongest *Muscles* upon their Breasts, whereby they are kept in the fittest Posture for swimming or flying, the *Center of Gravity* being so disposed as they are thereby enabled very easily, to keep their Heads above Water. And in those *Animals* that live within the Surface of the Waters,

there

there is a Bladder fill'd with Air, which has a *Duct* open to the outward Air on the Surface of the Water, whose *Orifice* is endow'd with a *Muscular Sphincter*, by which they let out and take in the *Air*, to render them *Specifically* lighter or heavier, than the Fluid they swim in, and so sink or emerge as their Occasions prompt them, or as they pass to a *Specifical* lighter or heavier *Element*; for by taking in more *Air*, they become lighter than they were, and so necessarily emerge, and by letting out some, they become heavier, and so sink. And it has been observed that Fishes have got up to the Surface of the Water meerly to change and alter the *Specifick* Gravity of this *Air*. And this Bladder is commonly full of *Air*, which is under some Degree of Condensation, from the *pressure* of the *Muscular* sides thereof; such to wit, as renders them in an *Æquilibrium* without any Pain, with that kind of Fluid they live most in, and they commonly alter their *Æquilibrium*, by the Compression or Expantion of this Bladder, which being cut out, the Fish ever after, either swims on the Surface or sinks to the Bottom. Birds and Fowls that sleep, resting on one Foot to ease the other, naturally lay their Heads under their Wings, that so the *Center* of the *Gravity* of their whole Body, may fall upon the Foot they

they stand on, and the *Animal* be preserv'd from overturning; and those Fowls that sleep so on the small Branches of Trees, incline a little backwards, that their Claws by the *Gravity* of their Body, without any *Muscular* Contraction, may grasp the Branch more strongly. These are wonderful Instances of *Divine Wisdom* and *Providence*; but those who please to consult that noble Work of *Borelli*'s, will find to their Satisfaction, a thousand such Instances, relating to this Head alone of *Muscular* Motion.

§ XLIII. The Bones consist of hard compacted *Fibres*, ty'd together by *Transverse* ones, after the manner of the *Muscles*; they are nourished by Blood Vessels which enter their Substance at several Places, which upon the compleat Growth of these *Bones*, are so straightned as to admit only what is sufficient to repair their Decays. All the considerably thick *Bones* are either hollow or spongious, and both sorts contain an *oleaginous* Substance, preserv'd in little *Vesicles*, which by the Heat of the Body, is exhal'd through the porous Substance of these *Bones*, to supple and anoint their *Fibres*, that they dry not, and thereby grow brittle. All the *Bones* are cover'd with a very sensible *Membrane* call'd the *Periosteum*, each large *Bone*, is considerably bigger at the Extremities than at the middle, and that for very

ry wiſe Ends and Purpoſes: For 1. Thereby the *Articulations* are made ſtronger, for had they been leſſer or equal to the middle, our Limbs had been in hazard of being disjointed upon ev'ry Occaſion. And 2. By the largeneſs of theſe *Tubercles*, it comes to paſs, that in all the *Revolution* of the joint. The *Tendon* is kept at the ſame diſtance of the *Semidiameter* of the *Tubercle* from the Center thereof, *i. e.* the Center of Motion; whereby, in the *Articulations* of the Shoulder and Knee eſpecially, the Arm and Leg, is capable of moving round, more than a *Semicircle* which by no other Contrivance poſſible, but this cou'd be obtain'd. There are ſeveral and various manners of *Articulations* of the *Bones* into one another, wonderfully fitted for the Motions of the ſeveral Members, one is like *Ball* and *Socket*, by which the *Bone* can move equally any way; as the *Thigh-Bone* with the *Iſchium*; others are by way of *Charnal*, as the *Radius* with the *Ulna*; a third are only ty'd together by intervening *Cartilages*, as the *Vertebræ* of the Back. Now all theſe different *Articulations* are from the Neceſſity of the *Situation*, or Motion of theſe *Bones*. The *Bones* in order to be the moſt convenient that might be, ought to have been as light, as was reconcileable with a ſufficient degree of Strength, that the Inſtruments

ments of Motion, might not require too great an Expense of Spirits, to move them, and that the *mechanical* Machin might not become a Burthen to themselves; now the wise *Author* of *Nature*, has wonderfully provided for this, for he has made 'em light, by evacuating their middle Substance, and yet they are stronger by very far, than if they had compos'd one solid *Cylinder*; for *Galileo* has demonstrated, that of two *Bones* of equal lengths, and of equal Number of *Fibres*; the Strength of the one is the Strength of the other, as their *Diameters* are; so that a hollow *Bone* of a double *Diameter*, to a close one of the same Number of *Fibres*, is as 2 to 1, or the first is twice as strong as the second. This is most conspicuous in those *Animals* that are form'd to fly; it is wonderful, how light and yet how strong, the Quills of their Feathers and their *Bones* are, and this wonderful wise *End*, cou'd no otherways be obtain'd but by this Contrivance. *Borelli* hath shewn that these *Bones* are so many *Vectes*, of which the Center of the *Articulation* is the *Fulcrum*, the *Tendons* are the *Ropes*, by which the *Vires Motivæ* of the *Muscles* elevate, and move any weight, or overcome any Resistence. There is a wonderful, and exactly nice *Geometry* used by Nature in the Figure, Connexion, Order, and Motions of these

*Pillars*

*Pillars* of the Body, and of their Cover the *Muſcles*; it were alone a ſufficient Work, to ſhew all the *Neceſſities*, the wiſe *Contrivances*, and prudent *adaptions* of theſe admirable *Machines* for the benefit of the whole. I ſhall Inſtance only in two or three Particulars, and then proceed. 1. Then, what can be more wonderfully contriv'd than the *Back-bone*, had it been all of one entire *Bone*, without *Articulations*, we cou'd not have ſtoop'd or turn'd, but have gone forward like a Poſt or Pillar; had it been compos'd of a few *Bones* only, then the *Articulations* of theſe *Bones* in bending our Backs, muſt have made a large *Angle* upon their innermoſt edges, and ſo the *Spinal Marrow*, which ſends *Nerves* to all the Inferior parts of the Body, had been in hazard of being bruis'd at every ſtooping; and conſequently all the inferior Parts, had been in perpetual hazard of being depriv'd of the Inſtruments of their Motions; beſides that the whole wou'd not have been pliable, for the various Poſtures we have occaſion to put our ſelves in. If it had conſiſted of various *Bones* without intervening *Catilages*, we ſhou'd have had no more Benefit by it, than if it had been entire without *Articulations*, or had theſe *Articulations* been after the manner of ſome others of the *Bones*, we had not been capable of theſe Varieties of Motions that we now are, if each *Vertebra* had had its own proper *Cartilage*, the

*Articulations* might have been eaſily disjointed. So that we ſee, the Contrivance of this Hulk as it were, of the Body is the beſt that can be imagin'd; for by theſe many and ſmall *Articulations* upon ſomewhat plain and ſmooth Surfaces, ty'd by a common *Cartilage*, the Back, for the Security of that *Medullary* Subſtance, that runs down its *Cavity*, is bent after the manner of the *Catenarian Curve*, by which it obtains that *Curvature* that is ſafeſt for the included *Marrow*, and brings the greateſt degree of firmneſs; the oblique Proceſſes of each Superior and Inferior *Vertebra*, keeping the middle, from being thruſt backwards or forwards, to hurt the *Spinal Marrow*. Beſides, had not the *Tranſverſe Proceſſes* been ſo plac'd as they are, to keep the intermediate *Vertebra* from being thruſt backward or forward, then there wou'd have been no more reaſon why in *Inſpiration*, the *Ribs* ſhou'd have mov'd upwards and forwards, than backwards. But as they are now contriv'd, theſe *Proceſſes* force the *Ribs* to move upwards, and ſo lift up the *Sternum*, whence the *dilatation* of the *Thorax* proceeds, which cou'd not *dilate*, were there no *Tranſverſe Proceſſes*, or they otherwiſe diſpos'd. Now can there be a more manifeſt Inſtance of Council and Contrivance than this. Certainly, if infinite Wiſdom were ſuppos'd to have fram'd this part, it cou'd not have given a more pregnant Indication thereof.

2. As

2. As I have obſerv'd before, ſome *Bones* are articulated after the manner of *Ball* and *Socket*, as the *Humerus* with the *Scapula*, and that for this wiſe End, that the Arm might have all manner of poſſible Motions; but the *Ulna* and *Cubitus* is join'd by way of *Charnal*, that this *Articulation* might be the more ſtrong, for had it been after the former manner, we ſhou'd have had no Benefit thereby, for that *Articulation* of the Shoulder, takes off the Neceſſity of another ſuch here; the Hand by it, having all the Motions, that it cou'd have by another of the ſame kind, in this other *Articulation*; and we ſhou'd have loſt the Benefit of the greater Strength in this Joint. Thus we ſee, Nature in theſe Motions looſes no Benefit in the ſeveral Parts, that can conſiſt with the good of the whole. 3. Becauſe the *Tubercles* of the *Bones* of the *Fingers* and *Toes*, cou'd not be conveniently ſo large in Proportion to the middle of theſe *Bones* as they are in others, becauſe thereby in graſping or ſqueezing, theſe points of the *Fingers* which are at the *Articulations*, cou'd only come into *contact* with the Body ſqueez'd, and ſo the Action cou'd not be uniform; and by this ſmalneſs of theſe *Tubercles*, there was a hazard of bringing the direction of the Action of the *Tendons* of thoſe *Muſcles*, which contract the *Finger* and *Toes*, quite through, or very near the *Center* of *Motion*; whereby this Action wou'd have been

quite, or almost destroy'd. Now to prevent this Inconvenience, the *Ossa Sesamoidæa* (call'd so from their Resemblance to the Grains of *Sesamum*) are plac'd at the *Articulations* of these *Bones*, to serve as so many *Pullies*, about which the *Tendons* pass, at some distance from the Center of the *Articulation*, whereby the direction of the Motion of these *Tendons*, are remov'd always at the same distance from the Center of Motion, of the *Articulation*. The same Artifice is us'd in the *Knee*, by means of the *Patella*; these are wise and noble Ends, which the Wit of Men cou'd not have thought of, had they not observ'd them.

§ XLIV. How wonderfully is the Brain contriv'd, how carefully and strongly is that principal *Organ* of the Body, senc'd from external Injuries, by a thick Wall of hard *Bone*, and two very close and compact *Membranes*? What an infinite Multitude of *Glands*, are in the *Cortical* part, and of beginning *Nerves* in the *Medullar* Part, a Hundred of which do not exceed one single Hair? How commodiously are the *Nerves*, that serve for four of the *Senses*, and all the parts of the *Superior Regions*, sent out the shortest and safest ways through proper Holes in the Head? And those that serve the *Inferior Regions* of the Body, carry'd down in a *Bony Channel*. And it is very remarkable, that the *Veins* do not pass out, at the same Holes the *Arteries* enter; for if they

they did, then upon any violent Motion of the Blood, or any greater Quantity thereof than ordinary, lodg'd in the *Arteries*, their *dilatation* and *pulsation* wou'd compress the *Veins* against the *bony* sides of their Passage, and so occasion a *stagnation* and *extravasation* of the Blood in the Brain, to the destruction of the whole *Machin*; which by these different *Enteries* and *Exits* of these Vessels is prevented. These *Veins* also do not run along by the sides of the *Arteries* in the Brain, as they do thro' all the rest of the Body, which is also another wise Contrivance of Nature; for the *Arteries* here, were by their *dilatation* to press out their Juice or Spirit from the *Nerves*, into the *Muscles* of *involuntary* Motion, which wou'd have been hindred if the *Veins* had always gone along with the *Arteries*; for these *Veins* wou'd have receiv'd the impulse of the *Arteries*, and thereby in some Measure kept it from the *Nerves*. Next how strongly is the *Heart* built, and with what a force does it squeeze out the Blood into the *Arteries*; *Borelli* reckons it equal to the force of 3000 Pound Weight, and that 350 Pound Weight of Blood, passes through the *Heart* ev'ry Hour. How variously and effectually for its end, are its *muscular Fibres* arrang'd, and with what Judgment are its *Columns* and *Furrows* dispos'd, for the closer Contraction of its *Ventricles*! its point is turn'd a little toward the left side, for the more easy

ascent of the refluent Blood in the *Cava*, for thereby like a reclining inverted *Siphon*, the left *Auricle* becomes lower than the right. All the *Auricles* and *Ventricles* have *Valves*, whereby the Blood has a passage in its true course forward, but is hindred from returning the same way; which wou'd frequently happen, upon the equal *pressure* of the Blood on all Hands, and the Resistance of the sides of the Vessels, to the Ruin of the *Animal*; which Inconvenience is entirely prevented, by this prudent Contrivance and Situation of the *Valves*. And ev'n the Figure of the *Valves* themselves, in the several different Places, is for wise Ends and Purposes. But that which is most wonderful in this Affair, is the different *Structure* of the *Heart* in the *Fœtus*, from that of the same in adult Persons. In the Heart of the *Fœtus*, just opposite to the Mouth of the *Cava ascendens*, there is a Hole from the *Cava*, that opens into the *Vena Pulmonalis*, and is call'd the *Foramen Ovale*; there is likewise a Passage, which runs from the *Trunk* of the *Aorta*, to the *Trunk* of *Arteria Pulmonalis*. Now the Blood which is receiv'd by the *Placenta* from the Mother, is by the *umbilical Veins* carried into the *Porta*, from which it is sent to the *Cava*, by a Canal which goes strait from the *Trunk* of the one, to the *Trunk* of the other, by the *Cava* it is thrown through the *foramen Ovale*, into the *Vena Pulmonalis*, which carries

carries it to the left *Ventricle* of the *Heart*, by which it is ſqueez'd into the *Aorta*, to be diſpers'd over the Body. The Blood that comes from the *ſuperior Parts* of the Body, is diverted by the *Iſthmus* of the *Cava* from the *foramen Ovale*, and falls into the right *Ventricle*, which throws it into the *Arteria Pulmonalis*, from whence by the communicating Canal, it is immediately carried into the *Aorta*; ſo that the Blood that comes from the *Cava aſcendens*, paſſes only through the right *Ventricle*, whilſt that which comes from the *Deſcendens*, paſſes only through the left *Ventricle*. The reaſon of which Paſſages, is becauſe the Blood in the *Fœtus* cou'd not go thro' the *Lungs*, their *Veſicles* by their compreſſure upon the Blood Veſſels, obſtructing that Courſe; neither indeed, did the Blood need to paſs through the *Lungs*, the *Fœtus* being nouriſhed from the Mother, whoſe Fluids had already receiv'd, all the Advantages that it cou'd reap from the Air, in her *Lungs*; but when it comes into the *Air*, and is no longer nouriſhed from the Blood of the Mother, this *preſſure* is taken off from the Blood Veſſels, by the diſtenſion of the *Lungs*, after the manner already explain'd. And ſo finding a free Paſſage through the *Lungs*, it runs no more by the communicating Canal: And ſo that dries up; and by the Current in the *Pulmonary Vein*, the *Valve* of the *foramen Ovale* is ſhut ſo, that the Blood can no more

pass that way from the *Cava*. Now how wisely are these different Channels for the Blood contriv'd, for the different necessities of the *Fœtus*, before and after its Birth! This is a plain Indication of *fore-knowledge*, and such an one as nothing but Omniscience, is sufficient for. And this is certainly one of the most convincing Proofs of *Design* and *Counsel*, that can possibly be wish'd for; for to provide for an Event, that in the natural Course of things, must happen a long time after, is an infallible evidence, that the thing was foreseen, and the Provision design'd, by some intelligent Being. But this is not the only Instance of a *Precaution*, for it's evident, all the several Steps of the *Growth* and *Vegetation*, both of *Animals* and *Plants*, have been foreseen, and fore-design'd, by the wise *Author* of *Nature*; seeing, different Provisions are made, and different Circumstances adjusted, for these various Periods of their Lives.

§ XLV. What a noble piece of *Geometry* is manifested in the *Fabrick* of the *Eye*, and the manner of *Vision!* Without this *Organ*, *Animals* cou'd not provide themselves with Food, nor be forewarn'd of approaching Danger, and consequently, cou'd not guard against it; without the Benefit of *Light*, the animated part of this *System*, wou'd be but so many *Puppets*, tos's'd up and down by Chance and Fortune, without House or Habitation, and deprivd

priv'd of all the Pleaſures and Conveniences of Life. What a miſerable State wou'd it be, to be confin'd to perpetual Darkneſs, and never to behold the chearful Light? The Miſery of ſuch a Life is beyond Expreſſion and Conception: And on the other Hand, what can be more amazing, than that the Particles of Matter ſhou'd be ſo fram'd, as by their means to ſhew us the *Shapes*, *Poſitions*, *Diſtances*, *Motions*, yea and *Colours* of remote Bodies? How wonderfully muſt the ſeveral Coats and Humours of this little B*all* be diſpos'd, to tranſmit through them that fine, and ſubtile Fluid, which is emitted from *luminous* Bodies, and reflected from the Surfaces of *Opake* ones; and united on the bottom of the *Eye*. Theſe things are not only contriv'd and fram'd with ſo great Wiſdom and Skill, as not to admit of a better; but to any one who attentively conſiders them, they ſeem of ſuch a Nature as ſcarcely to allow any other Method, for it ſeems impoſſible that *Light* ſhou'd repreſent *Objects* to us, at ſo vaſt a diſtance, but by the tranſmiſſion of ſome fine Fluid, from the *Objects* upon the *Eye*. And it ſeems impoſſible that any other Compoſition of the *Eye*, ſhou'd be equally fitted for that end. The *Globe* of the *Eye* is *ſpherical*; it is compos'd of ſix *Coats*, and three *Humours*, the firſt *Coat* is call'd the *Conjunctiva*, and makes the White of the *Eye*. The ſecond *Sclerotica*, it is thick, hard, and ſmooth, *Opake* behind,

behind, but *Transparent* before; where it makes the third Coat call'd the *Cornea*, from its Resemblance to a piece of *Transparent* Horn, it has a greater convexity, than the rest of the *Globe* of the Eye, consists of several *Laminæ*, which are nourish'd by so small Blood Vessels, as to obstruct very little of the Light. It is of an exquisite Sense, that upon any touch, the Tears might be squeez'd from the *Lachrymal Glands*, to wash and clean it. The fourth *Coat* is the *Choroides*, it lies under the *Sclerotica*, it hath little *Glands* which separate a black Liquor, which *Tinctures* the internal side thereof (which is otherwise of a whitish Colour) for hindring the reflected Light from disturbing the Pictures of Objects; this Coat has a Hole before, which it called the *Pupilla*, for admitting the Light. The fifth is the *Uvea*, which is nothing but the Circumference of the *Pupilla*; It is compos'd of circular and straight *Fibres*, to contract or dilate, according to the strength or weakness of the Light, for when the Light is too strong, the *circular Fibres* contract the *Pupilla*, that their Force hurt not the *Eye*; and when it is weak, the straight *Fibres* dilate it, to let in more Rays, for the more distinct Vision. On the inside of the *Uvea* from its *Circumference* which joins the *Choroides*, rises the *Ligamentum Ciliare*, by which the forepart of the *Eye* is press'd outward, and the *Retina* backward,

or

or the *Axe* of the *Eye* lengthned, at the approach, of too near Objects. The ſixth *Coat* is the *Retina*, which covers like a Net the bottom of the *Eye*, it is only a fine expanſion, of the *Fibres* of the *Optick Nerve*; upon this Coat, the Pictures of Objects are fram'd. The firſt Humour is call'd the *Aqueous*, it lies immediately under the *Cornea*, it is thin and liquid, and of a ſpirituous Nature, inſomuch that it will not freeze in the greateſt Froſt. The ſecond is the *Chryſtalline*, next the *Aqueous*; it is convex on both ſides, and reſembles a double convex *Lens*; it is covered with a fine *Coat*, call'd *Aranea*. The third is the *glaſſy* Humour, it is thicker than the *Aqueous*, and thinner than the *Chryſtalline*, it gives a *Spherical* Figure to the *Eye*, upon its back part, is the *Retina* ſpread, which it keepeth at a diſtance from the *Chryſtalline* Humour, requiſite to receive the diſtinct impreſſion of Objects. The *Optick Nerves* are inſerted in the inſide of the *Optick Axes*, whereby the middle point of every Object is diſtinctly ſeen, for the Center of the Inſertion of the *Optick Nerve* is inſenſible, as Monſieur *Mariotte* has ſhewn by Experiment. And conſequently, had the Center of the *Optick Nerves* coincided, with that of the *Retina*, the middle point of any Object, had been inviſible; but by this lateral Inſertion of theſe *Nerves*, the point of the Object which is inviſible in the one *Eye*, becomes viſible in the

the other; for it it impossible, that the Rays shou'd fall on the inside of both *Eyes* at the same time. The light which comes from the several points of Objects, is so refracted (by the *Cornea* and *Chrystalline Humour* principally) as to meet again upon the *Retina*, and there to paint in the same Order and Proportion, with the Object, the Image thereof, (as is evident by taking off that part of the *Dura Mater*, which covers the backside of the *Retina*, from the *Eye* of any dead *Animal*, and then placing the *Eye* in a fit Hole, of a dark'ned Room; for looking then upon the back part of the *Retina*, we shall see through it, the Pictures of external Objects painted upon its inside) and these Pictures propagated by Motion, along the *Optick Nerves*, are the Cause of *Vision*. Now what can be more admirable than this structure of the *Eye*; ev'ry part contributing something toward its Perfection. It is situated in the *Head*, the most eminent part of the Body, next to the most noble and vital *Organ*, in the whole Composition: Either in the fore part, or the sides, according to the necessary occasions of the Animal: In *Man* it takes in but a *Hemisphere* of Vision, in *Birds* almost a whole *Sphere*, and in some timerous Animals, as *Hares* and *Conies*, their Eyes being so protuberant, and placed so far backwards on the sides of their Heads, they must see a whole Sphere quite round, with the least Motion of these *Organs*.

The

The *Cornea* is more *convex* than any other part of the *Eye*, by which all the Rays are gathered, to pass through the *Pupilla*, and few of 'em lost on the *Uvea*. The *Aqueous Humour* being thin, easily changes its Figure, either when the *Ligamentum Ciliare* contracts, or both the oblique *Muscles* protrude, the Bulb of the *Eye*, to render it oblong, when Objects are too near; the *Fibres* of the *Uvea* contract or dilate the *Pupilla*, according to the Degrees of the Strength of the Light. The *glassy Humour* keeps the *Retina* at a due distance from the *Chrystallin*, the Images are painted upon a Skin, produc'd by the Expansion of the *Optick Nerves*, for the more easy conveyance of the Impression to the Brain. The *Choroides* is tinctur'd black, that the Rays that pass through it may not be reflected back again upon the *Retina*, and so confound the Object. The *Optick Nerves* are inserted on the inside of the *Axes* of the *Eye*, that the whole Object may be distinctly view'd; the Hairs of the *Eyebrows*, with those on the *Eyelids* defend it from filth and light Bodies that swim in the *Air*; the continual Motion of *Eyelids*, moisten and sweep the *Cornea*, else it would dry or grow dirty; it is sunk in a Hole, wall'd with a strong Bone, to keep it from more powerful Injuries. The several refractive Virtues of the *Coats* and *Humours*, serve to correct the Errors arising from the different *Refrangibilities* of the Rays of Light,

Light. Our Eyes are double, to secure both sides from Danger, because if the Objects were near, however one *Eye* were plac'd, we cou'd not distinctly perceive them that shou'd be situated towards the sides of our Body, and so cou'd not guard our selves from the Dangers, thence arising. Besides, we cou'd not distinguish the distance of Objects by one *Eye*, for our two *Eyes* are like two different Stations in *Longimetry*, by the assistance of which, the distance between two Objects is measured. As also, when one *Eye* is accidentally rendred useless, we enjoy the Blessings of this so necessary a Sense, by the Benefit of the other. It is observable that the Figure of the *Chrystallin* Humour of Fishes, is a great deal nearer to a *Sphere*, than that of Land *Animals*, and that because of the different refractive Virtue of Water from Air, for that convexity which wou'd unite the Rays of Light coming through Air, will not unite the same so perfectly at a point, in the same distance, coming through Water. In those *Animals* that gather their Food from the Ground the *Pupill* is *Oval* or *Elliptical*, the greatest *Diameter* going transversly from side to side; in those that seek their Food on higher Places, its greatest *Diameter* goes from the top of the Head towards the Feet *perpendicularly*; these two different Figures being wonderfully fitted to the different necessities of these *Animals*. Those living

Creatures

Creatures that by their Figure, and for other reaſons, have no Motions of their Neck, have a Cluſter of *Hemiſpherical Eyeballs* which ſend in the Pictures of Objects all around them; and thoſe that ſeek their Food in the dark, have their *Retina* coloured white, which reflects the light and enables them to ſee beſt in the leaſt light; theſe are wonderful and ſurprizing Inſtances, of *Foreſight* and *Counſel* in that Being that fram'd theſe *Organs*; but that which to me is moſt ſurprizing in this Affair, is that in all Animals, whoſe *Organs* are found; they ſhou'd have been ſo nicely fram'd in all the infinite poſſible Varieties over and under, as to repreſent Object at a due Diſtance, of that Magnitude that has the juſteſt Proportion and trueſt Analogy, to the Magnitude of each particular Animal. What the real Magnitudes of Bodies are, I doubt no body can juſtly tell, nor were it of any uſe to us to know, ſince their *Analogical* Magnitudes to the Magnitude of our Bodies, is all that we have any Concern about. Thus taking our own Hand, Foot, or Height for our Standard, all things about us are repreſented in a conſtant uniform Proportion to theſe, ſo that we are thereby informed of that Diſtance and Magnitude of Objects that is moſt natural and familiar to us, and is alſo moſt neceſſary for our Security and Preſervation: And the ſame is true of every other Animal ſmall, or great, thus take an *Elephant*, a *Man*, and a *Mite*,

*Mite*, and present the same Object to them all three, and it shall appear, not of the same Magnitude to them, but in a Magnitude in some sort, reciprocally proportional to their own Bulks, that is, to the Elephant, less than to the Man, and to the Mite, much greater than to either, and this of necessity from the different Magnitudes, aud Fabrick of their *Nerves* and *visual Organs*; and for the necessity of their Preservation, and seeking their Food. Now we know from the Laws of *Opticks*, that had the *Retina* been remov'd farther from, or brought nearer the *Chrystallin* Humour, or (keeping the *Retina* at the same Distance from that Humour) had it consisted of two *Segments* of a less or greater *Sphere*, the Vision had been indistinct or none at all; or had the Distance been fitted exactly in the *Focus* of the *Chrystallin*, but had it consisted of *Segments* of *Spheres*, less or greater, than those of our *Chrystallin Humour*, that are at present, we had seen Objects ev'n at a due Distance, either bigger or less than we now behold them, which wou'd have expos'd us to a thousand dangerous Mistakes; for Example, the Precipice that perhaps was not many Feet from us, might have appear'd at some Paces Distance, and we have tumbled down, ere we were aware, or the *Atom* that we now scarce take Notice of, wou'd have covered all our view, and hindred us from taking in any other Object; in a Word, besides that thus

thus we shou'd not have discovered that *Magnitude* of Objects, which has the most proper and fit Analogy to us, which wou'd have had a Thousand fatal Consequences, had our Eyes magnified Objects, any thing considerably, we cou'd have seen but a very small part of them at once, and Twenty dangerous things might have been in our ways, which we cou'd not have discovered, but by a great deal of Pains; so that our progressive Motions, must have been slower than those of *Reptils*, and then ev'ry little Particle, likewise, wou'd have been able to have damn'd up, and obstructed our Sight; and had our *Eyes* diminished Objects considerably, we cou'd have seen them but faintly and indistinctly, all minute Bodies wou'd have vanished, and we might have been destroy'd by those which we thought at a distance. In one Word, there are infinities of different Ways, our *Eyes* might have possibly been form'd, none of which cou'd have brought with it, the Advantages the present Structure does. Can there then be a more pregnant and convincing Evidence of the *Being* of an *infinitely wise* Power, who out of the infinite possible Varieties, of disadvantagious Fabricks of this *Organ*, has singled out that only one, that was best; he certainly deserves not to enjoy the Blessings of his *Eye Sight*, whose Mind is so deprav'd, as not to acknowledge the Bounty and Wisdom of the Author of his Nature, in the *ravishing* and *astonishing* Structure of this noble *Organ*.

§ XLVI. *Hearing* is the next Senſe in Dignity to *Seeing*, (for I reckon *Feeling* a general one, of which the reſt are only particular *Modifications*) without which our Lives wou'd be very Comfortleſs. It is by Means of this Senſe, we enjoy the Benefits of Converſation, and the Pleaſures of *Muſick*; and by it we are forewarn'd of thoſe Dangers, our Eyes cannot inform us of; and what can be more wonderful than that the ſame *Medium* of Air, ſhou'd ſerve us for ſo many different, yet neceſſary Uſes: By it our Vapours are ſupported, and buoy'd up to the higher Regions, to be there form'd into Snow or Rain, according to the Exigencies of different *Climates*; by it's Motion our Winds are produc'd, which ſail our Ships, and purify our *Atmoſphere*; by drawing it in we live, and our Blood is fitted to perform its *Circulations*; by it Sounds are convey'd to our *Ears*, and other Mens Thoughts to our Minds. The internal Parts of the *Ear* are theſe, 1. The *Meatus Auditorius*, which is a contorted Paſſage for the outward Air, running firſt upward, and then downward; here are many *Glands*, which ſeparate a viſcid glutinous Matter, which hinders Inſects, or any hurtful thing, from corroding the *Tympanum*, which is a ſecond principal part of the internal *Ear*. It is a thin *Membrane*, like the Head of a Drum, ſtretch'd upon a Bony Circle, behind which is the *Barrel*, in the Cavity of which there are four little Bones call'd the *Hammer*, the

the *Anvil*, the *Stirrup*, and the *Os orbiculare*. In this B*arrel* there are ſeveral Holes, one of which opens, behind the Palate of the Mouth, and receives Air to ſupply theſe Cavities, that have no Communication with the Air, coming in by the outward *Ear*. Next to the B*arrel*, is the *Labyrinth*, which ends in the *Veſtibulum*, and is follow'd by the *Cochlea*, which is a Paſſage reſembling a *Snail's Shell*, in it the Auditory *Nerves* terminate. Now when a Sound is propagated in *Undulations* through the Air (the *Sonorous* Body ſtriking the Ambient Air, by many repeated *Vibrations*, excites theſe *undulations* in it, after the manner any heavy Body thrown into a ſtanding Lake, raiſes in the Water, Waves in a Circle round it) theſe are gathered by the *Concha*, or external *Ear*, and carried through the *Meatus Auditorius*, to the *Tympanum* or Drum, on which beating, the four little Bones that are in the B*arrel*, are thereby mov'd; and as the Drum is ſtruck by the external Air, after the ſame manner is the internal Air mov'd by theſe little Bones; and this internal Air, thus mov'd, makes an Impreſſion upon the *Auditory Nerves*, in the *Labyrinth* and *Cochlea*; ſo that as the external Air ſtrikes the *Drum*, ſo does it move the Bones in the B*arrel*, to ſtrike the internal Air after the ſame manner; and as it is mov'd, ſo accordingly is the Impreſſion made upon the *Auditory Nerves*, and all this *Apparatus* ſeems intended, to hinder the Sound from coming with too

great Violence upon these *Nerves*, for we find that too sudden, and violent a Noise, is still able to disturb these slender *Tubes*, and sometimes to disorder them so, as to deprive us of this *Sense*. Now how wisely is this necessary and pleasant *Sense* contriv'd, for the Conveniences of Life! Had it been more exquisite, than every little Noise had been capable of disturbing us, the buzzing of a Fly, or the Noise of our own Breath, wou'd have pierc'd our *Ears* like a Peal of Thunder; and the Motion of every little *Atom* wou'd have rob'd us of Rest; and had this *Sense* been any thing considerably more dull, we shou'd have been in proportion thereto, depriv'd of all the Pleasures and Advantages thence arising: So that it's evident our *Hearing*, is nicely adjusted to the Conveniences and Necessities of Life, which is a plain Instance of *Design* in the Fabrick of this *Organ*; the same might be demonstrated of the two remaining Senses, which for Brevities sake I must now omit.

§ XLVII. I have before observ'd, that all the Canals except the *Arteries* have *Valves*, by which their Fluids are permitted to go forward, in their Course, but hindered from returning back, all these *Valves*, opening toward the term of the natural Motion, of these Fluids, but shutting by the Pressure of the Blood in a contrary Direction, and thereby obstructing that backward Motion. These *Valves* are visible, not only in the *Veins* but in the *Lymphaticks*,

the

the *Lacteals* and *Ductus Thoracicus*; and it is obſervable that this laſt *Channel* always goes up the left ſide, that by the Pulſation of the great *Artery*, upon which it immediately lyes, the *Chyle* may be propell'd upward. It is likewiſe remarkable, that all the Branches of the *Arteries* which go off, at any ſmall Diſtance from the *Trunks*, do all unite again in one *Trunk*, whoſe Branches communicate with one another, and with others, as before; and that for this wiſe End, that when any ſmall *Artery* is obſtructed, or cut, the Blood may be brought by the communicating Branches, to the Parts below the Obſtruction, which muſt have otherwiſe been depriv'd of Nouriſhment. The *Velocity* of the *Blood* in the extreme *Arteries* is conſiderably leſs, than that of the ſame at the *Heart*, or its entry into the *Aorta*, becauſe it is of theſe extreme *Arteries* the *Glands* are form'd, and by them the ſecretions are made, which as was before demonſtrated, require different *Velocities* in the Blood, to ſecern the different *Fluids* in theſe *Glands*: This Diminution of the *Velocity* is evident from the Proportions Dr. *James Keill*, (to whoſe Accurate *Compendium*, of the *Anatomy* of *Humane Bodies*, I have always had recourſe, where my Memory fail'd me) has giv'n us all the Branches of the *Arteries* to the great Trunk, whereby it appears the *Diameter* of the *Aorta*, does not bear a greater Proportion, to the primary Branches of the *Arteries*, than 5 to 7: And doubtleſs the odds is greater in the ſmaller Branches.

Branches. How frugal has Nature been in the Structure of the *Veins!* for because of the less Pressure of the *Blood*, against the sides of these widening Channels, the thickness of their Walls is in proportion less, than those of the *Arteries*. Besides, that only those *Veins* that run *perpendicular* to the *Horizon*, are endow'd with *Valves*, which stick to their Sides like so many Thimbles; which when the Blood presses back, are fill'd, and so stop its Passage, but are compress'd by the forward Motion of the Blood. Now these *Valves* were useless in other *Veins*, for their widening Channels, give no occasion to the Blood to push backward, its Gravity acting laterally and not backward, as in those *perpendicular* to the *Horizon*; the small Branches of these *Veins*, communicate with one another, for the same ends and purposes that the *Arteries* did; and having now occasion to speak of the containing Vessels I cannot omit here the wonderful Contrivance of Nature in the Position of the several Parts of the *Fœtus* in the *Uterus*; the *Skull* whereof in the first part of the time of its *Gestation* being very thin, large and only *Membranous*, the *Thorax* and *Abdomen* with the Limbs are so dispos'd as to make the Head always emerge out of the Fluid it lies in, or at least preserves it in a Direction that it is still upward, with its Face toward its Mother's Belly, but about the time of its Delivery the Skull thickens, and hardens, the Limbs and Members stretch out, and so the Head becomes the heaviest place in the Body whereby it tumbles over, and acquires that Posture which is fittest for its Delivery. These are signal Instances of Counsel and Foresight, in the Formation of these *Organs* and Parts, but I hasten to a Close.

§ XLVIII. Having I think sufficiently made out that great Truth, to wit, that we are *wonderfully*

*fully made*, though I have pointed only at a few of thoſe Inſtances that the *Animal* Fabrick and *Oeconomy* affords, I now come to make a few general Obſervations under one Head, and ſo to put a Cloſe to this *Chapter*. It is very remarkable, that thoſe *Animals*, *Plants*, and *Minerals*, that are of moſt uſe, and advantage to us, are ſuch as will grow almoſt in every *Soil* and *Climate*, and are more productive of their kind than others, and are found in moſt Places. Thus *Iron* is found almoſt every where, *Corn* is the Product of all Soils, and Climates, while other more curious and nice *Plants* will only thrive in their proper Soils: Thus *Hens*, *Geeſe*, and *Turkies* are more Productive than *Crows* or *Jackdaws*, and *Conies*, and *Hares*, than *Foxes* or *Lyons*; thus a *Crane*, which is but ſcurvy Meat, lays but two Eggs, and the *Alka* and ſome other Sea Fowls, but one, whereas the *Patridge* and the *Pheaſant* hath Fifteen or Twenty, and thoſe which lay fewer, and are of moſt value for Food, lay oftner, as the *Woodcock* and the *Dove*. What is more admirable, than the fitneſs of ev'ry Creature for the uſe we make of him? The *docility* of the *Elephant*, ſo long employed in War, the *Inſitiency* of the *Camel*, for travelling in the parch'd and dry Deſerts, the gentleneſs of the Sheep, the Cleanneſs, Beauty, Strength, and Swiftneſs of the Horſe, whoſe Breath, Foam, and ev'n Excrements are ſweet, and thereby ſo well fitted for our Uſe and Service! How frugally has Nature avoided any uſeleſs Expence of *Organs*, when the Circumſtances of the *Animal* wou'd have rendred 'em ſo? Thus thoſe *Animals* that are ſlow of their Nature, have no very quick ſight, it being uſeleſs to ſuch, ſince their ſlowneſs allows them time to dwell longer on an Object, as *Snails* and

*Moles*;

*Moles*; but these that are endow'd with a quicker Motion, have brisker Eyes, and a more quick piercing Sight, as *Hawks* and *Hares*. Those *Animals* also, that have no Ears have no *Organs* for making a noise with; because wanting Ears, these other wou'd be useless, as *Fishes* and other Inhabitants of the watery *Element*. So also, those *Animals* which have Teeth on both Jaws, have but one Stomach, because these Teeth render more Stomachs useless; and those *Animals* that have no upper Teeth or none at all, have three Stomachs to supply the want of these Teeth; as in Beasts, the *Paunch*, the *Read* and the *Feck*; and in all granivorous Birds, the *Crop*, the *Echinus* and the *Gizzard*. A Man which has a bigger Brain in proportion to his Body than any other *Animal*, has a better and more easily manageable Hand; whereas a *Monky* that has little Brains, and consequently can have no great use for much dexterity, has not so well a shap'd nor easily applicable a Hand. These, and a Thousand such Instances of *Wisdom*, *Counsel*, and *Meliority* in the Contrivance and Fabrick of the several *Animals*, may be gathered by any one who will consult the Writings of natural Historians. But those who will not be convinc'd by the Instances I have brought, that there is a God who rules *in the Kingdoms of the Earth*, who number'd all our Parts, and appointed them out their several Ends and Uses, I am afraid will not be prevail'd upon by those behind.

*The End of the First Part.*

# PHILOSOPHICAL PRINCIPLES OF RELIGION.

## PART II.

Containing the *Nature* and *Kinds* of *Infinites*, their *Arithmetick* and *Uses*, and the *Philosophick Principles* of *Reveal'd Religion*, now *first* published.

By GEORGE CHEYNE, *M.D.* and *F.R.S.*

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# RELIGION
OF
# PRINCIPLE

# The PREFACE

## To the Second PART.

BEfore the *Reader* takes the trouble, to enter on the *Second Part*, it's fit he be appriſed of a few things, that may prevent his miſtaking my meaning, in the more difficult Propoſitions, or may eanble him to run thro' the whole with more Pleaſure.

I. The *firſt Chapter* is intended only, as an Introduction to the Two Subſequent, to the *Third* eſpecially, and for clearing up and demonſtrating in the moſt familiar and eaſy way, the Nature and Properties of *Relative Infinites*. The Foundations of the *Arithmetick of Infinites*, and the Structure built thereon, publiſhed by me in the *former Edition* of this Work, having been doubted of, or miſtaken by ſome. The whole now, I hope, is clear and unqueſtionable. I have borrowed a few things from the *Third Chapter*, for the eaſe of thoſe, who either might not have Humour and Leaſure, or might not have apply'd themſelves ſufficiently to ſuch Studies, as to be able to go quite through *that Chapter*. And yet might be content to ſee this curious Speculation eſtabliſhed here.

II. The *Second Chapter* contains many Particulars of Weight and Moment. The *Foundation* is this. The *Supreme Creator* of all Things, and the whole *Syſtem* of Creatures, from the higheſt *Seraphim* down to *Brute Matter*, are here together conſidered as it were an *Infinite Cone*, (like the *Shadow* of the dark ſide of the *Earth*, circumſcribed by the Light of the *Sun* in the empty Spaces of our *Syſtem*,) whoſe *Baſe*, is the *Supreme and Abſolute Infinite*, the Origin of the Being and Faculties of all created Things; and its *Body*, is the whole *Syſtem* of Creatures, from the higheſt *Spiritual Intelligence*; deſcending in a perpetual Subordination, and continual Scale, down to *Brute Matter*; or if there be any Creature lower than this. It is true, in this *Metaphor* or *Reſemblance*, the *Baſe* is to be ſuppoſed at an *Abſolutely Infinite* Diſtance, from the Body of the *Cone*. (as the *Sun*, whoſe Rays define the dark *Cone* of the Earths Shadow, is diſtant from the *Earth*) But then, as all the *Sections* in a *Cone*, Parallel to the *Baſe*, are ſimilar to the *Baſe* and to each other. So in this *perpetual Scale* of Creatures, conſidered in one view, together with their Creator, every *Species* and ſet of Creatures is ſimilar to the *Baſe*, and to every other *Species* and ſet of Creatures, from the Higheſt to the Loweſt, *i. e.* every *Species* and *ſet* of Creatures of a higher Order, has the great *Lineaments*, and *prominent Out Lines* of their *Baſe*, the Origin of all Being and Per-

Perfections, more ſtrongly, clearly, and largely, repreſented and expreſs'd on and by them, and every *Species* and *ſet* of Creatures of a lower Order, has the ſame *Lineaments* and Characters, repreſented and expreſs'd on and by them, but in a more Weak, more Faint, and more contracted manner. And ſince *Life*, *Activity*, and *Fecundity*, are among the moſt *Univerſal*, *Primitive*, and *Original* Qualities, of the *Baſe*, the *Source*, and *Origine* of all Being and Perfections: So every *Species* of Creatures and each individual of every *Species*, muſt in a higher or lower Degree, according to their Rank in the Scale of Exiſtence, partake of thoſe *Primitive* and *Original* Qualities. If this *Principle*, and *Foundation*, thus ſhadow'd out, may be allow'd me, and ſure methinks it is Evident, from the Nature of Things *à Priori*, from all Experiments and Obſervations hitherto made on our Material *Syſtem* of Things, *à Poſteriori*, and even from the moſt genuine and ſimple reflections of our Minds within our ſelves. Then it will follow,

I. That there is a perpetual *Analogy*, (Phyſical not Mathematical) running on in a Chain, thro' the whole *Syſtem* of *Creatures*, up to their *Creator*.

II. That the Viſible are Images of the Inviſible, the Senſible of the Inſenſible, the *Ectypical* of the *Archetypical*, the *Creatures* of the *Creator*, at an abſolutely infinite diſtance.

III. That the Arguments from the *Attributes* of the *Creator*, to the Qualities of the *Creature*,

with due regard to the absolutely *infinite* distance, is Just and Conclusive, *& vice versâ.*

IV. That, as there are *Objects*, intirely opposite and *disparata*, so there must be Faculties, in Intelligent Creatures, suited to those different *Objects*, differing, according to the diversity of the *Objects*.

V. That if *Gravitation* be the Principle of *Activity* in *Bodies*; That of *Re-union*, with their Origin, must by this *Analogical* Necessity, be the Principle of Action in *Spirits*.

VI. That *Material Substances*, are the same with *Spiritual Substances*, of the higher Orders, at an infinite distance, or that *Material Substances* are *Spiritual Substances* infinitely condensed or contracted, since in the *Scale* of *Existence*, the *first* are supposed at an *infinite* distance from the *latter*.

VII. That, there is some *Analogy* between the *Constitution*, Temperaments and Complexions of *Spiritual Beings*, and the known different Textures, *Elements*, and Faculties of *Material Substances*.

These I think, as they are necessary Consequences from the preceeding Principle, so they are the main Pillars, and some of the principal Propositions of this *Second Chapter*, which, if understood and granted, every thing else will either be easily receiv'd, or may be safely rejected, without any hazard to the main *System*.

After all, seeing my whole Intention and Design, in advancing and publishing these *Specula-*

*culations*, was to beget in the Minds of Men, Noble, Generous, and Magnificent Sentiments, of *God* and *his* Works, that, thereby they might be more powerfully engaged, to Love, Adore, and Serve *Him*. To convince them of the *Degeneracy* and *Corruption* of the whole Race of Mankind; of the neceſſity, of expanding and cultivating their *Superior* Faculties, by a faithful Obedience, to the Divine *Attraction* and *Drawings* in their Hearts; and thereby, of begetting in their Souls, *Charity*, or the *pure Love* of *God*, and of all his Images in a proper Subordination: All which can by no other Means be brought about, but by a careful copying after, and imitating the *Model* and *Pattern* the BLESSED JESUS has ſet us in his Life and Doctrine. I ſay ſince this was my whole end and aim, in advancing and publiſhing theſe *Speculations*. If any Perſon, ſhall think fit to contravert them, he may do it very ſafely for me. For being ſatisfied, in the Honeſty and Simplicity of my Intentions, and of the Uſe and Benefit theſe Speculations have been to my ſelf, for theſe Ends and Purpoſes. I am firmly reſolved, not to ſpend my time in idle Diſputes. If others differ with me, about the Truth and Reality of theſe *Speculations*, or their uſefulneſs to, and influence on the Ends propoſed, or are not diſpos'd to reliſh or receive them, they may let them alone or reject them, it is equal to me. All I ſhall be ever prevail'd on to do, in ſuch a caſe (ex-

cepting always, in case those who either are my *lawful Superiors*, or whom I look on my self obliged in Conscience to obey, shall command otherwise,) shall be; to amend, alter, or retract, what I shall be perswaded is amiss in the future *Editions* of this Work; if it shall have any more.

III. The *Third Chapter* is what the *Reverend* and *Ingenious* Mr. *John Craig* sent me about Seven Years ago, when I desired him (being low in my Health, and otherwise engaged) to write me down his Thoughts on, correct or alter, what I had formerly published on this Head in the *first Edition* of this Work, in order to a Second Edition. I have altered or added nothing, but one *Note* before his *Additions*, and that in *Italick* Characters.

To conclude, if any Person, by either of the Parts of this Work, shall be moved to Adore, Worship, or Love, the *lovely and adorable Author of his Being*, (who is wonderful in all his Works, and great in the least,) I say, if any one shall be wrought on thereby, to love Him more, or serve Him better, I shall have the whole reward of my Labour, having intended it solely for his *Glory* and the *Good* of my fellow Creatures; and having I hope, in the whole, and each single part, as far as my Weakness and Corruption wou'd permit, disengaged my self, from all *sinister* Ends, from all *Fraud*, *Malice*, *Vain-glory*, and *Hypocrisy*.

The

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## *Advertisement.*

THE Errors of the Press, in the *first Part*, not being such as can stop the *Intelligent Reader*, I beg he will mend the following ones, of the first and second Chapters of the *Second Part*, which were the most Material I could observe. *Page* 8. *Def.* 9. *Relative Nothing* is said here to be generated by a perpetual *Substraction*, tho' the Signs be alternatly + and —. for these Reasons, because *Relative Infinite*, was said to be generated by a perpetual *Addition*, and because that after the first Term, every Two succeding ones in Relative *Nothing* 1 *is equivalent* to — 0 1 thus $1 - 1 + 1 - 1 + 1 - 1$ &c. is $1 - \overline{1 + 1} - \overline{1 + 1} - \overline{1 + 1}$ &c, $= 1 - 01 - 01 - 01$ &c. and so

in

in other Cases. *p.* 22. *line* 10. for effect *read* affect: *p.* 27. *l.* 10. for $\infty^{n-1} : n : : 1 : 0$. *read* $\infty^{n-1} \infty^{n} : : 1 : 0$. *p.* 30. *l.* 7. for indefinite, *r.* Infinite. *p.* 32. The Errors of Calculation here, are corrected. *p.* 163. *p.* 41. *l.* 13. instead of Distance, *r.* Time employed in the Motion of Light. *p.* 42. *l.* 12. instead of waies, *r.* Times. *p.* 84. *l.* 23. instead of Relations, *r.* Revelations. *p.* 101. *l.* 17. instead of are essentially, *r.* are not essentially. *p.* 108. *l.* 21. instead of Limit, *r.* Light. The Errors of the *Third Chapter*, will not stop those who wou'd otherwise understand it.

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# Part II.

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# PART II.

## CHAP. I.

### *Of the Nature and Kinds of* Infinites. *Of ſome of their reſpective Qualities, and of a New Arithmetick of* Infinites.

THAT we may reaſon as cautiouſly as poſſibly we can, about Matters ſo intricate, and ſo far remov'd from the common way of Thinking, as the Nature and Qualities of *Infinits*, and the other Subjects of this Chapter are; we ſhall begin with *Definitions* and *Axioms*, and proceed to ſome General *Propoſitions*, demonſtrated after the plaineſt manner, till we

obtain *Principles* to found our consequent Reasonings on; and then draw such Corollaries, from the several Parts, or from the whole, as arising necessarily from them, may be of use, to ascertain some Speculations advanced in the foregoing *Treatise*; or may otherwise help, to conduct the Understanding in those other *Sciences*, where they may find a place.

### *Definition* I.

QUANTITY is what may be encreas'd or diminished.

Tho' this *Definition* may not exhaust the *Metaphysical* Nature of *Quantity*; yet it points out that Quality in it, that is here chiefly regarded; for ev'ry quantity may be encreas'd or diminished, and that continually, as shall be afterwards shown.

### *Definition* II.

A BODY is an extended, impenetrable, passive, divisible, unintelligent Substance.

This *Definition* also, tho' it exhaust not the internal essence and intimate Nature of Matter, yet it summs up, its sensible and most constant Qualities, by which it is distinguished from every thing else.

*Defi-*

*Definition* III.

The inherent *Principle* of *Activity*, in the great Bodies of the Univerſe, is *Gravitation* or ſomething *analogous* thereto.

Tho' I am perfectly convinced, from the Simplicity and Uniformity of the Divine Nature, and of all his Works, that there is ſome one great and univerſal *Principle*, runing through the whole *Syſtem* of Creatures *analogically*, and congruous to their Relative Natures; which is the ſame in all Bodies great and ſmall, and the *Origin* of all their Natural Actions upon one another, with regard to their different Circumſtances; and that there is not a different *Principle* for the Natural Actions of the *Leſſer Bodies* from that which is the *Principle*, of the Natural Actions of the *Greater Bodies* of the *Univerſe*, but one and the ſame *Principle* in both, acting differently in different Circumſtances. Yet ſince *Gravitation*, or ſome thing *Analogous* thereto, ſeems neceſſary for accounting for the Conſtant and Regular Motions, and Actions upon one another, of the *Great Bodies* of the Univerſe. *Gravitation* or ſomething *Analogous* thereto muſt be a neceſſary Conſequence in the *Greater Bodies* of the Univerſe, of this more Univerſal Principle, and the *Origin* of the Activity of *Bodies*.

*Definition* IV.

A SPIRIT, is an extended, penetrable, active, indiviſible, intelligent Subſtance.

*Body* and *Spirit* are in ev'ry other Quality oppoſit, except in *Extenſion*, therefore as the foregoing *Definition* of Body, ſumms up its ſenſible and moſt conſtant qualities, ſo to aſſign the *Definition* of Spirit, there was nothing to be done, but to joyn the oppoſite Qualities of Body, to that of Extenſion or extended Subſtance.

*Definition* V.

The *Principle* of Action in Spiritual Subſiſtences, is, or ought to be, that Eſſential one of REUNION with the *Origin* of their Being, impreſs'd on ev'ry Individual of this Rank of Creatures.

The Univerſal *Principle* of *Action*, mentioned in the third Definition, that runs through all the *Syſtem* of Creatures, muſt *analogically* be carried through ev'ry Individual of *Spiritual* Beings, and can be nothing but this Eſſential Principle of REUNION with the *Origin* of their Being, as ſhall be afterwards demonſtrated at large.

*Defi-*

*Definition* VI.

A *finite Quantity* is that, of which the Bounds or Limits, beyond which it cannot reach, is *assignable.*

Thus a Line is finite, when both its Extremities are given, or the Points which are its Limits, beyond which it cannot reach, are *assignable:* An *Area* is finite, when it's terminating Lines are *assignable*; a *Solid* is finite, when its terminating Planes are *assignable*, a *Number* is finite, when the Unities (which are its Limits) of which it consists, or the bounds beyond which it cannot reach, are *assignable.*

*Definition* VII.

An *Infinite Quantity* (in its simplest nature and lowest degree) is that, some one or more of the Limits or Bounds of which, beyond which it cannot reach, are not *assignable.*

Thus a *right Line*, one or both of whose Extremities are not *assignable*, or the Points beyond which it cannot reach, are not *assignable*, is an *infinite right Line.* An *Area*, one or more of whose terminating Lines are not *assignable*, is an *Infinite Area*; a *Solid*, one or more of whose terminating Planes,

are not *assignable*, is an *Infinite Solid*. A number, encreasing continually, whose last encrease, is not assignable, or the Bounds beyond which it cannot reach, is not *assignable*, will at last make an Infinite Number.

*Scholium.*

An Infinite *Number*, may be suppos'd to be Generated, by the perpetual Addition of a finite Number to it self. Thus $1+1+1+1+1$, *&c.* $a+a+a+a+a$ *&c.* become infinite. Or, it may be supposed to be Generated, by the perpetual Addition of finite Numbers, encreasing in a regular Progression, and in one constant Proportion one to another. Thus $1+2+4+8+16$, *&c.* (where the finite terms, perpetually encrease in the *ratio* of 1 to 2.) and $1+a+a^2+a^3+a^4$ *&c.* (where the finite Terms, perpetually encrease in the *ratio* of 1 to $a$) become infinite. And it is the same in all other infinite *Series*, regularly Generated; or lastly, the infinite Number, may be supposed to be generated by the perpetual addition of finite Numbers, in no certain proportion one to another, nor in any regular progression, such as $7+1+30+5+2+25$ *&c.* Of these last kinds of Infinites, we have here no consideration, for being of no constant or regular Nature, but merely casual and fortuitous

they

they can afford no *Medium* for reaſoning. The Principal Deſign of this Chapter, ſo far as it concerns theſe two kinds of Infinites, is to find out a *Method*, for reſolving the ſecond kind of Infinites into the firſt when it is poſſible; in order then to obtain a juſt Notion of theſe Infinites, let us firſt diſtinguiſh Infinite in general, into *Relative* or *Creaturely* Infinite, and *Supreme* or ABSOLUTE Infinite (of which the firſt is but a Created Image or Picture, as will be afterwards ſhown) let ⊙ ſtand for finite in general, and ∞ ſtand for infinite in general as they reſpect Numbers; then ⊙ 1 and ∞ 1 will be finite and infinite (as they reſpect Numbers) of the loweſt Degree and ſimpleſt Nature. Unity being the ſimpleſt number.

### *Definition* VIII.

*Relative Infinite* (in its ſimpleſt Nature and loweſt Degree) is an infinite Quantity, as it ſtands related to a given Finite, by the perpetual Addition of which to it ſelf it is generated.

Thus ∞ 1. is a *relative Infinite*, as it ſtands related to 1, a given finite, by the perpetual Addition of which to it ſelf, it is generated; that is, ∞ 1 = 1 + 1 + 1 + 1 + 1 &c. And ∞ *a*, is a *relative Infinite*,

as it stands related to the given finite $a$, by the perpetual Addition of which to it self it is generated, or $\infty a = a + a + a + a + a$ &c.

*Scholium.*

In the same Relation, that relative Infinite stands above a given finite in *ascending*, in the same may another quantity be supposed to stand below it, in *descending*, in which Case, we shall have a *relative infinitely great* Quantity, in *ascending* above the given finite; and a *relative infinitely little* quantity, in *descending* below it. So that relative infinite in general, may be aptly distinguished, in respect of the given finite, into *relative infinitely great*, and *relative infinitely little*. For brevities sake, we shall call the first *relative Infinite*, the second *relative Nothing*.

*Definition* IX.

*Relative Nothing* (in its simplest Nature and lowest Degree) is an *infinitely little* quantity, as it stands related to a given finite, by the perpetual Substraction of which from it self, it is generated. Let $o$ stand for relative Nothing.

Thus $o1$, is a *relative infinitely little* quantity, as it stands related to Unity, by the per-

perpetual Subtraction of which from it self, it is generated; that is $o1 = 1 - 1 + 1 - 1 + 1 - 1 + 1 - 1$ &c. and $o\,a$, is an infinitely little quantity, as it ſtands related to the given finite $a$, by the perpetual Subtraction of which from it ſelf, it is generated; that is $o\,a = a - a + a - a + a - a$ &c.

*Definition* X.

An *Indefinite Quantity* (in its ſimpleſt Nature and loweſt Degree) is ſome mean proportional, between finite, and relative infinite or Relative Nothing.

For, as in *Deſcending* from 1 to 0, we do not immediately ſlip from finite to relative Nothing, but muſt neceſſarily paſs through the intermediate ſteps $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ &c. in Arithmetical Progreſſions; and in *aſcending* from 1 to $\infty$ we muſt paſs through the ſteps between both 2, 3, 4, 5, &c. in the ſame kind of Progreſſions. So in the *Geometrical* Progreſſions, in *deſcending* from 1 to 0, we muſt paſs through theſe mean Proportionals $\sqrt[2]{0}$ $\sqrt[3]{0}$ $\sqrt[4]{0}$ &c. and in the ſame Progreſſions, in *aſcending* from 1 to $\infty$, we muſt paſs through the mean Proportionals $\sqrt[2]{\infty}$ $\sqrt[3]{\infty}$ $\sqrt[4]{\infty}$, &c. and theſe we call *Indefinites*. Thus in *Geometry*, if we cou'd imagine a *Circle*, drawn upon the ſumm of a finite right Line repreſenting 1, and an infinite right Line repreſenting

senting $\infty 1$, as a *Diameter*. A Perpendicular erected on the Point where these Two Lines meet, reaching the *Circumference*, wou'd represent the *Indefinite* right Line implyed by $\sqrt[2]{\infty}\,1$. Let $\propto$ stand for such *Indefinite* Quantities in general.

*Scholium.*

Unity being the simplest *Finite* Number, by consequence $\infty 1 = 1+1+1+1+1$ &c. must be the simplest *Infinitely great* Number. And $0\,1 = 1-1+1-1+1-1$ &c. must be the simplest *infinitely small* Number. And by reason the greater the Number, denominating the Root is, the less the Root it self will be, therefore $\sqrt[\infty]{\infty 1}$ (= to any Finite Number greater than Unity) will be the simplest Indefinite. Put $\sqrt[\infty]{\infty 1} = y = \infty^{\frac{1}{\infty}}$ therefore $\frac{1}{\infty} L\,\infty = Ly$. but $L\,\infty = \infty$ (as will be seen by the last Chapter) therefore $\frac{1}{\infty} \times \infty = Ly$. that is $\frac{\infty}{\infty} = 1 = Ly$. But 1 may be the *Logarithm* of any finite Number, greater than Unity, in the Scale of proportionals $1^{\circ}.\ a^{1}.\ a^{2}.\ a^{3}.\ a^{4}.$ &c. therefore $\sqrt[\infty]{\infty}\,1$, may be any finite Number greater than Unity. The *Indefinits* of the first degree, that is wherein the Number denominating, the Root is an integer, may be universally thus expres'd

$$\sqrt[m]{a} = \overline{\sqrt[m]{\infty}} = \overline{1-1}\Big|^{\frac{1}{m}} = 1 + \frac{1}{m} + \frac{1 \times \overline{m+1}}{m \times 2\,m} +$$

$+\frac{1\times\overline{m+1}\times\overline{2m+1}}{m\times 2m\times 3m}+\frac{1\times\overline{m+1}\times\overline{2m+1}\times\overline{3m+1}}{m\times 2m\times 3m\times 4m}+$ &c. Now as $\infty 1 = 1+1+1+1+1$ &c. and $0 1 = 1-1+1-1+1-1$ &c. and $\sqrt[\infty]{\infty} 1$. are of the simplest Nature, so also are they of the lowest Degree. The superior Degrees being generated of $\infty 1$, after the same manner that $\infty 1$ is of 1, for if we add $\infty 1$, perpetually to it self, we shall have a *relative infinitely great* quantity, of the simplest Nature in it's kind, but of a higher Degree. *viz.* $\infty 1+\infty 1+\infty 1+\infty 1$ &c. $=1+1+1+1+1+1+1$ &c. $+1+1+1+1+1+1+1$ &c. $+1+1+1+1+1$ &c. &c. = (Since a perpetual Addition of any quantity to it self, is equal to a Multiplication by $\infty 1$) $\infty\overline{1\times 1+1+1+1+1+1}$ &c. $=\infty 1\times\infty 1=\infty^2$. So $\infty a+\infty a+\infty a+\infty a$ &c. $=\infty\times\overline{a+a+a+a+a+a}$ &c. $=\infty\times\infty a=\infty^2 a$. After the same manner $0 1 = 1-1+1-1+1-1$ &c. If substracted perpetually from it self, it becomes $0 1-0 1+0 1-0 1$ &c. $=\overline{1-1+1-1+1-1}$ &c. $-\overline{1-1+1-1+}\overline{1-1}$ &c. $+\overline{1-1+1-1+1-1}$ &c. $-\overline{1-1+1-1+1-1}$ &c. $+$ &c. = (since a perpetual Substraction of a quantity from it self is the same with a Division by $\infty$) $\frac{1-1}{+1}$

$\frac{+1-1+1-1\ \&c.}{\infty} = \frac{0}{\infty} = \frac{1}{\infty} \times 0 = 0 \times \frac{1}{\infty}$

$+1-1+1-1\ \&c. = 0^2$. Thus we have a relative Nothing less than 0, but of a superior degree, for as *relative infinitely great* Numbers, encrease in their value, by being raised to superior degrees, so *relative infinitely little*, decrease, because the first perpetually ascend from Finite, the Latter *descend* perpetually further from it. And thus all the Degrees that Finite Quantities admit of, may be form'd, from relative Infinits and Nothings. And as we have Indefinites $\sqrt[m]{\infty}$ between 1 and Infinite in *ascending*, and $\sqrt[m]{0}$ between 1 and 0, in descending, so *Analogous* to their Natures we have the superior Degrees $\sqrt[m]{\infty^n}$ and $\sqrt[m]{0^n}$. Nature in all these cases admitting of no Bounds nor Limits.

*Definition* IX.

*Absolute* or SUPREME Infinite, in a proper Sense, is one, Individual, admitting of neither encrease, nor diminution, or of any Operation that *Mathematical* Quantity is subjected to.

This will be better Understood afterwards.

*Defi-*

*Definition.* X.

*Abſolute Nothing* in a proper Senſe, is neither capable of encreaſing nor diminiſhing, nor of anywiſe altering any *Mathematical* Quantity to which it is apply'd, but ſtands in full oppoſition to *abſolute* Infinite.

*Axioms.*

I. That which is greater or leſs than any poſſible Finite Quantity how great or little ſoever, muſt be a *relative Infinite*, *Indefinite*, or *Nothing*, and which of all theſe Three, the given Quantity is, the ſtate of the Caſe will always determin.

Beſides, *Infinite*, *Indefinite*, and *Nothing*, relatively conſidered, we have no *Idea's* of Quantity, and the Definitions of theſe already given, apply'd to the ſtate of the Caſe under conſideration, will always determine which of theſe, the Quantity aſſigned muſt be.

II. Number being the ſimpleſt Meaſure of Quantity, and a proper Unity being the Meaſure of all Number, a proper Unity is the Meaſure of all Quantity.

That Unity, is the Meaſure of all Integers is evident: And in Fractions, the *Denominator* determines the proper Unity, whereof

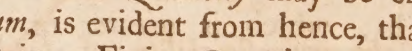
whereof the *Numerator* determines the Number. Wherefore in the following Propositions instead of Quantity, we shall frequently use it's Measure Number, to express their meaning and to demonstrate their Truth.

*Propositions.*

I. *Quantity* may be encreas'd or diminish'd in *Infinitum.*

Case 1. That *Quantity* may be encreas'd in *Infinitum*, is evident from hence, that since it is certain, a Finite Quantity may be added to a Finite, what may be once done, may be done again and again, and consequently may be done any Number of Times, greater than any Finite Number how great soever, that is by *Definition* 4. and *Axiom* 1. Quantity may be encreas'd in *Infinitum.*

Case 2. That *Quantity* may be diminished in *Infinitum* is evident from hence that out of the given Quantity *AB*, by the *Sixth Book of Euclid*, you may take out any given $\frac{m}{n}$ Part, and out of the Remainder, you may also take out any $\frac{m}{n}$ Part, for the same Reason that you can take it out of the first given Quantity *AB*, and so on continually, and



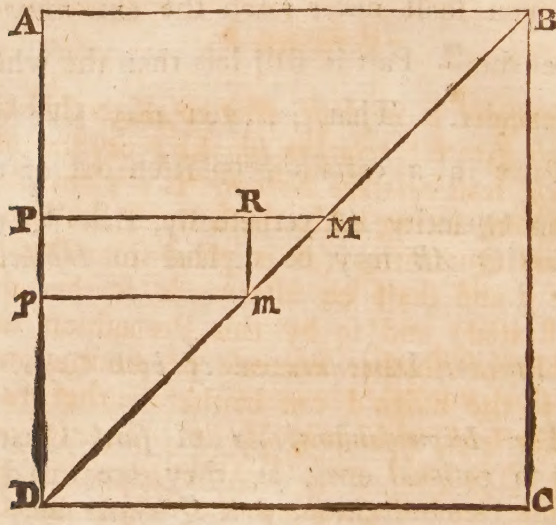

yet

yet you ſhall never reach the extremity *B*, ſince the $\frac{m}{n}$ Part is ſtill leſs than the whole Remainder. That is, you may take out $\frac{m}{n}$ Parts in a certain proportion out of the given Quantity *AB* perpetually, that is, the Quantity *AB* may be divided in *Infinitum*. q. e. d.

*Another Demonſtration of both Caſes.*

The *Incommenſurability* of *ſurd* Quantities to *rational* ones, as they are call'd, is a full Demonſtration, that *Quantity* may be encreas'd or diminiſh'd in *Infinitum*.

Let




Let *ABCD* be a ſquare, whoſe *Diagonal* is *DB*, putting the ſide $AD = 1$. Then is *AD*, to *DB*, as 1 to $\sqrt{1}$. Take in the ſide *AD*, apart *Pp* the leaſt poſſible draw *PM. p m.* parallel to *AB* and *Rm* parallel to *AD.* Since the Triangles *BAD* and *MRm* are ſimilar, *Rm* will ſtill be to *mM* as 1 to $\sqrt{1}$. therefore it is impoſſible to find in *AD*, a Part how ſmall ſoever, that taken, any Finite Number of Times, how great ſoever, ſhou'd be equal to *mM.* So that let *AD* be divided into parts how ſmall ſoever, and how many ſoever, yet ſtill *DB* may be further divided. That is *per Def.* 5. and 4. and *Axiom* 1. *DB* may be divided in *Infinitum*, and *AD* encreas'd in *Infinitum.* q. e. d.

*Corol-*

*Corollary* I.

Hence it is evident, that to aſſign the *abſolutely* greateſt *relative Infinite*, or the *abſolutely* leaſt *relative Nothing* is a plain Contradiction, ſeeing both theſe are ſtill *Mathematical* Quantities (as is plain from *Def.* 1. 4. & 5 and ſhall be afterwards further demonſtrated) and ſo by this Propoſition, are capable of further encreaſe or diminution; and ſo the aſſign'd can neither be the *greateſt* nor *leaſt*, *abſolutely*.

*Corollary* II.

Hence, and from *Def.* 4. & 5, we may diſcover wherein the *ſpecifick* difference between *Finites* and *relative Infinites* or *Nothings* conſiſts: To wit, in the limited encreaſe or diminution of the former, and in the perpetuity of the encreaſe or diminution of the latter, for aſſoon as the encreaſe or diminution in theſe latter ſtops, they become limited and aſſignable, and conſequently Finite, and thereby, no part of the deſired Infinite.

*Corollary* III.

Hence it appears, that an Infinite of either sort is (as to all *Arithmetical* Operations on it, with due regard to the perpetuity of its encrease, or diminution,) of the Nature of an *unknown* quantity in *Algebra*. For as in this, from the state of the *Problem*, we perform *Arithmetical* Operations on it, as it were known, and thereby we sometimes do, and sometimes do not determine its value, but by Approximation: So on this, we may perform the like Operations as upon an unknown quantity, with due regard to its particular nature, and the State of the *Problem*, and thereby often discover the *specifick Genius* of its Progression, which is always *Regular* and *Harmonious* as will be afterwards seen.

*Proposition* II.

*Unity* divided by an *infinite number* of *Unities* makes the Quotient *relative Nothing* or $\frac{1}{\infty 1} = 0$.

*Demonstrat.* $\infty 1 = 1 + 1 + 1 + 1 + 1$ &c. *per Def.* 4. & $01 = 1 - 1 + 1 - 1$ &c. *per Def.* 5. divide 1, by $1 + 1 + 1 + 1 + 1$ &c. and by the common Operations of *Algebra*, you shall have $1 + 1 + 1 + 1 + 1$ &c.) $1 (1 - 1 + 1 - 1 + 1$ &c. $= 0$. q. e. d.

*Corol-*

*Corollary* I.

From hence it is evident, that *Unity* divided by *relative Nothing* is equal to $\infty$ 1. for $1-1+1-1+1-1$ &c. $=0)\ 1\ (1+1+1+1+1+1$ &c. $=\infty\ 1$ therefore $\frac{1}{0}=\infty$.

*Corollary* II.

Hence alſo it follows, that $\infty \times 0 = 1$. But this may be demonſtrated otherwiſe thus. $\infty\ 1 = 1+1+1+1+1+1$ &c. *per Def.* 4. Multiply both by *o* and then it is, $\infty\ 0 = 01+01+01+01+01$ &c. $= 0 \times \overline{1+1+1+1+1+1}$ &c. but by *Prop.* 2. $0 = \frac{1}{\infty}$. and $1+1+1+1+1+1$ &c. $=\infty$. therefore $\infty \times 0 = \frac{1}{\infty} \times \infty = \frac{\infty}{\infty} = 1$ q. e. d.

*Propoſition* III.

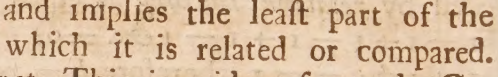
As *Finite* in General is to *relative Infinite* in General, ſo is *relative Nothing*, to *Unity*. That is $\Theta : \infty\ \Theta :: 0 : 1$.

*Demonſtrat.* By 1. *Corollary Prop.* 2. $\frac{1}{0} = \infty$. Multiply both by $\Theta$ then $\frac{\Theta\ 1}{0} = \infty\ \Theta$ that is $\Theta\ 1 = \infty\ \Theta\ 0$. therefore $\Theta : \infty\ \Theta :: 0 : 1$. q. e. d.

*Proposition* IV.

*Relative Nothing* is a real *Mathematical* Quantity, and implies the least part of the Finite, to which it is related or compared.

*Demonstrat.* This is evident from the Generation of *Relative Nothing*, assign'd in *Def.* 5. But to demonstrate the Proposition, without regard to this Definition, let *AH* infinitely produced from *A*, be divided into equal Parts *AB*, *BC*, *CD*, *DE*, *&c.* So that an equal part of this Line




may denote any Number. Supposing $AB=1$, let $x$ denote any Number, for Example $x=AB$, $y=Ab$ then by the common Rules of Division $\frac{1}{y-x}=\frac{1}{y}+\frac{x}{y^2}+\frac{x^2}{y^3}+\frac{x^3}{y^4}$ *&c.* Now suppose $b$ infinitely near to $B$, then $y-x=Bb=\dot{x}$ & $\frac{1}{\frac{x}{}}=\frac{1}{y-x}$ but $x=\dot{x}+\dot{x}+\dot{x}+\dot{x}$ *&c.* by *Def.* 4. that is $x=\dot{x}\times\overline{1+1+1+1}$ *&c.* therefore $\frac{1}{\frac{x}{}}=\frac{1}{\dot{x}}+\frac{1}{\dot{x}}+\frac{1}{\dot{x}}+\frac{1}{\dot{x}}$ *&c.* But by Supposition $AB=x=1$ therefore $\frac{1}{\frac{x}{}}=1+1+1+1+1$ *&c.* $=\infty 1$. But by *Corollary* 1. *Prop.* 2. $\frac{1}{0}=\infty$ therefore $\frac{1}{\frac{x}{}}=\frac{1}{0}$ and

$\frac{1}{0}$ and consequently $\dot{x} = o$. But $\dot{x}$ being a real *Mathematical* Quantity, by *Def.* 1. *o.* also must be a real *Mathematical* Quantity, and the least part of Unity to which it stands related or compared. q. e. d.

### *Corollary* I.

Since $\infty$ ascends from the given Finite, in the same manner that *o* descends below it, and since *o* is a real *Mathematical* Quantity, so also must $\infty$ be. And as *o* is the least relatively below it in it's own order, so is $\infty$ the greatest relatively above it in it's order, but both below and above these, we may *descend* or *ascend* in a higher order or degree, without Bounds or Limits.

### *Corollary* II.

When a *Curve* is said to meet with it's *Asymptot*, and when in the common *Hyperbola*, we obtain the *Area* $\frac{1}{1-1}$ or in the Example proposed we put $y = x$, in these and such like Cases we mean only, that in the first case the *Ordinate* is infinitely little, in the Second, we mean the least part of the *Abscifs*, and in the Third that $y$ and $x$ must differ only, by an *infinitely little* part of $x$, or by $\dot{x}$ only; and not that

they are *absolutely* equal, else there wou'd be no Division, and consequently no Quotient, as shall be afterwards shewn.

*Corollary* III.

Since by *Corollary* 1, *2d Prop.* $\infty = \frac{1}{0} = \frac{1}{1-1+1-1+1}$ *&c.* $= 1+1+1+1+1$ *&c.* Since also $\frac{1}{1-1} = 1+1+1+1+1$ *&c.* as is evident from the common Rules of Division, seeing the Two first Terms only effect the Quotient, (all the rest being but repetitions of the same Terms,) and lastly, seeing the same Quotient is obtain'd whether the Divisor be $1-1$ or $1-1+1-1+1-1$ *&c.* the reiterated Multiplication of the Quotient upon the Divisor, producing the same effect (in the actual Operation of the Division) which soever of the Divisors we choose, we may safely put in common Cases $1-1$ or $2-2$ or $a-a$ for $0$.

*Corollary* IV.

From hence, and *Def.* 4. we may discover the true meaning of the Expression, when it is said a *Quantity* is greater than *Infinite*, or one *Infinite* is greater than another. In these

these and the like Expressions $\infty 1 = 1 + 1 + 1 + 1 + 1$ &c. is always supposed the common Standard or Measure, to which all others are compared. Proper *Unity* being by *Axiom* 2. the common Measure of all Quantity, and when a Quantity $x$ is said to be greater than *Infinite*, the meaning is, that it may be an Infinite, greater than $\infty 1$. and when $\infty 2$ is said to be greater than $\infty 1$, it is no more than to say $2 < 1$. In all these *relative Infinites* admitting of comparison, there is still a particular Finit, to which each respectively are related, and it is on these Finites that the comparing the *Infinites* among themselves is founded. Thus $\infty 2 = \frac{2}{0} = \frac{2}{1-1} = 2 + 2 + 2 + 2$ &c. when compared with $\infty 1 = \frac{1}{0} = \frac{1}{1-1} = 1 + 1 + 1 + 1$ &c. the finite Parts of these Two Infinites, *viz.* 2, and 1, are the Subjects of the Comparison. And when $\infty 2$ is said to be greater than $\infty 1$, it means only that the Finite's Parts, of which they are Generated, are as 2 to 1, or these in the first are double of those in the second. It is the same thing as in $\Theta 2$, compared with $\Theta 1$, or $2x$ with $1x$, nothing is meant in either, but that 2 is greater than $1 : \Theta$, and $x$, and $\infty$, being as to this Case, equally unknown Quantities, which may be thrown

out in the Comparison, and *universally*, in all relative Infinites $\infty n$, $= n+n+n+n$ &c. and in all relative Nothings $o n$, $= n - n + n - n + n - n$ &c. $\infty n = \frac{n}{o}$ is the expression of the *Ratio* of the first Series, and $o n = \frac{n}{\infty}$ is the expression of the *Ratio* of the second Series, and these Two $\frac{n}{o}$ and $\frac{n}{\infty}$ are proper Subjects of the comparison, where $n$ may admit of all the Relations that Finites have among themselves.

## *Proposition* V.

*Relative Infinites*, *Indefinites*, and *Nothings* (with the proper Limitations peculiar to each) admit of all the Degrees and *Arithmetical* Operations, that Finite or *Mathematical* Quantities are subjected to.

*Demonstrat.* This is evident from *Def.* 4, 5, and 6. and the *Scholia* adjoyning to these, and is also manifest from the precedent *Prop.* and it's first *Corollary*, as to relative Infinites, and Nothings; and shall be afterwards shown, as to Indefinites, to wit, that all these are still *Mathematical* Quantities, capable of Encrease and Diminution *in Infinitum*, and consequently must admit

admit of all these *Arithmetical* Operations (with proper Limitations peculiar to each) that finite Quantities are subjected to. And to confirm this, we may observe in *Nature*, a resemblance of these higher Degrees of *relative Infinites*, and consequently by *Analogy*, of *relative Nothings* also. For if *Space* be *Infinite*, as shall be afterwards Demonstrated, it must be supposed equal to an infinite *Cube* or *Sphere*, whose *Diameter* will be as $\infty$ 1, it's Section through this *Diameter* as $\infty^2$, and it's *Content* as $\infty^3$. q. e. d.

*Proposition.* VI.

*Relative Infinite* has, to the Finite with which it is compared, no finite Proportion, or Finite when compared with it's proper relative Infinite becomes relative Nothing.

*Demonstrat.* This is evident from 4 *Corollary Prop.* 4. the *Ratio* of the relative Infinites in general $\infty n = n + n + n + n$ &c. being $\frac{n}{o}$ that is $\infty n = \frac{n}{o}$ therefore $\infty n : n :: 1. o.$ q. e. d. on the other side let us suppose the *Ratio* of the relative Infinite in general $\infty n$ to $n$, to be a finite Ratio $\frac{s}{r}$ then $\infty n = \frac{r}{s}$ which is impossible by 2 *Corollary*

*rollary Prop.* 3. wherefore since $\infty n : n :: 1 : o$ by compoſition of Ratio's, $\infty n + n : n :: 1 + o : o$ but $1 + o$ is but 1. therefore $\infty n + n$ is but $\infty n$, or $n$ a finite Quantity when compared with it's relative Infinite $\infty n$ becomes o. q. e. d.

*Corollary* I.

Hence, *relative Infinite* in General, is to *Finite* in General, as *Unity* is to *relative Nothing*: or any *Finite*, when compared with *relative Infinite* in General, becomes *relative Nothing*: that is $\infty : \Theta :: 1. o$.

*Demonſtrat.* By the *precedent Propoſition* $\infty n : n :: 1 : o :: a : o a$, and by converſion of ratio's $\infty n : a :: n : o a$. Suppoſing then $a$ to be a *Finite* quantity, nothing but an Infinite number of relative Nothing or $o$'s being equal to 1, by *Corollary* 2. *Propoſition* 2. $o a$ muſt be ſtill $o$, or $a - a + a - a + a - a$ &c. $= o$, by *Corollary* 3. *Propoſition* 4. wherefore $\infty n : a :: n : o$, and by Compoſition of *ratio*'s $\infty n + a : a :: n + o : o$, put $n = 1$ and $a = \Theta$ then $\infty + \Theta : \Theta :: 1 + o : o$: and ſince $1 + o$ is but 1, therefore $\infty + \Theta$ is but $\infty$; wherefore $\infty : \Theta :: 1 : o$, or when any Finite is compared (by Addition, (or by Subtraction by Diviſion of ratio's)) with *relative* Infinite in General, it becomes *relative Nothing* q. e. d. The true *Analogy* is this,

$\infty n$

$\infty n$ or $n + n + n +$ &c. $a : : n : a - a + a - a + a - a$ &c. but becauſe $a$ is ſuppoſed Finite, $a\ o$ is the ſame (in Caſes of Addition and Subtraction) with $o$. But were $a = \infty 1$, then $a - a + a - a + a - a$ &c. wou'd be $\infty - \infty + \infty - \infty + \infty - \infty$ &c. $= \infty \times \overline{1 - 1 + 1 - 1 + 1 - 1}$ &c. $= \infty \times o = 1$, and $\infty n - \infty n + \infty n - \infty n$ &c. $= \frac{\infty}{\infty} n = n$.

## *Corollary* II.

Put $n$ equal to any Integer, then $\infty^{n-1} : n : : 1 : o$, but $o^n : o^{n-1} : : o : 1$, for the firſt being reduced, becomes $\infty : 1 : : 1 : o$, and the ſecond being reduced, becomes $o : 1 : : o : 1$; and therefore when $\infty^{n-1}$ is to be added to, or ſubtracted from $\infty^n$, it becomes $o$; and when $o^n$ is to be added to, or ſubtracted from $o^{n-1}$ it becomes alſo $o$, by *Scholium Def.* 6. and the Caſe is the ſame when the Inferior Powers ſuppoſe $\infty^{n-2}$, or $\infty^{n-3}$ &c. are to be added to, or ſubtracted from $\infty^n$, or when $o^n$ is to be added to, or ſubtracted from the Inferior Powers $o^{n-2}$ or $o^{n-3}$ &c. in all ſuch caſes its evident from the precedent *Prop.* and its 1. *Corollary*, that $\infty^{n-2}$ $\infty^{n-3}$ and $o^n$ become $o$.

*Scho-*

*Scholium.*

From these *Propositions* and *Corollaries*, an *Arithmetick* of Infinites may be drawn out, different from any hitherto published, of no contemptible use, or narrow extent in *Algebra*, and *Geometry*; as will be in some measure shown by the Third Chapter.

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*The Arithmetick of Infinites.*

ADdition. $2\infty + 3\infty = 5\infty$. $a\infty + 2a\infty = 3a\infty$. $\infty^2 + 2\infty^2 = 3\infty^2$. $\infty^n + p\infty^n = 1+p\infty^n$. $a\infty + e\infty = a+e\infty$. $3\infty + 10 = 3\infty$. $a\infty + a = a\infty$. $\infty^2 + \infty = \infty^2$. $\infty^n + \infty^{n-1} = \infty^n$. *Let q be less than n, by a finite Integer, then* $\infty^n + \infty^{n-q} = \infty^n$.

Substraction. $5\infty - 2\infty = 3\infty$. $10a\infty - 3a\infty = 7a\infty$. $6n\infty - 4n\infty = 2n\infty$. $5\infty - 7\infty = -2\infty$. $7\infty^3 - 5\infty^3 = 2\infty^3$. $9\infty^p - 5\infty^p = 4\infty^p$. $5\infty^p - a\infty^p = 5-a\infty^p$. $3\infty - 7 = 3\infty$. $a\infty - a = a\infty$. $\infty^p - \infty^{p-1} = \infty^p$. *Let q be an Integer, less than p, then* $\infty^p - \infty^{p-q} = \infty^p$.

Multiplication. $\infty \times 3 = 3\infty$. $\infty \times a = a\infty$. $\infty \times \infty = \infty^2$: $\infty^2 \times \infty^3 = \infty^5$. $\infty^p \times \infty^q = \infty^{p+q}$. $a\infty \times e\infty = ae\infty^2$. $3\infty$

$a \times$

$a \times 4\infty x = 12\infty^2 ax. \quad -2\infty x - 3\infty = 6\infty^2. \quad -\infty a \times +\infty = -\infty^2 a.$

Diviſion. $\frac{\infty}{2} = \frac{1}{2}\infty.$ or $\infty \frac{1}{2}. \quad \frac{\infty a}{e} = \infty \frac{a}{e}. \quad \frac{2\infty}{\infty} = 2. \quad \frac{3\infty}{4\infty} = \frac{3}{4}. \quad \frac{\infty a}{\infty e} = \frac{a}{e}. \quad \frac{\infty 2}{\infty} = \infty.$

$\frac{\infty 3}{\infty} = \infty^2. \quad \frac{\infty^p}{\infty^q} = \infty^{p-q}. \quad \frac{+3\infty}{-\infty} = -3. \quad \frac{-4}{-2}$

$\frac{\infty}{\infty} = +2. \quad \frac{-\infty a}{+\infty e} = -\frac{a}{e}.$

Fractions. $\infty \frac{2}{3} + \infty \frac{4}{5} = \infty \frac{22}{15}. \quad \infty \frac{a}{e} + \infty \frac{p}{q} = \infty \frac{aq+ep}{eq}. \quad -\infty \frac{3}{2} + \infty \frac{4}{5} = \frac{2}{15}\infty.$

$\infty \frac{a}{e} - \infty \frac{p}{q} = \infty \frac{aq-ep}{ep}. \quad \infty \frac{a}{e} \times \infty \frac{p}{q} = \infty^2 \frac{ap}{eq}. \quad \infty \frac{a}{e}\Big) \infty \frac{p}{q} \left(= \frac{ep}{qa}. \infty \frac{5}{4}\right) \infty \frac{2}{3} \left(= \frac{8}{15}.\right.$

Thoſe who are ever ſo little acquainted with the *Specious Arithmetick*, will eaſily underſtand the reaſon and Truth of theſe Operations.

## *Propoſition* VII.

*Indefinite Quantities* are not properly either Finite or Infinite, but between both.

*Demonſtrat.* An Indefinite Quantity is ſome mean Proportional, between Finite and relative

lative Infinite, *per Def.* 6. that is, one of those Infinites will be $\infty = \sqrt{\infty}\,\Theta$ put $\Theta = 1$, and then $\sqrt{\infty}$, will be an Indefinite Number, now this $\sqrt{\infty}$ can neither be Finite (and this manner of reasoning will hold good of any other Indefinite whatsoever) nor Indefinite, not Finite, else $\Theta^2$ would be Infinite, which is impossible; nor Infinite, for the least possible Infinite, must be Infinite in general, divided by the greatest possible Finite $x$, and then if $\sqrt{\infty}$ be Infinite, $\sqrt{\infty} = \frac{\infty}{x}$ and $x^2 = \frac{\infty^2}{\infty} = \infty$. which is also absurd. Again if $\sqrt{\infty}$ be Infinite, then is $\infty \times \frac{1}{\sqrt{\infty}} (= \sqrt{\infty}) =$ Infinite, and $\frac{1}{\sqrt{\infty}}$ = to it's relative Infinitely small part, or it's relative Nothing $= 0$, and so $\infty \times 0 = \infty \times \frac{1}{\sqrt{\infty}} = (\sqrt{\infty} =)$ to Infinite. But by *Corollary* 2. *Prop.* 2. $\infty \times 0 = 1$, and instead of $\infty \times 0$, putting it's value 1. in this last equation, it will be $\infty \times 0 = 1 = \infty \times \frac{1}{\sqrt{\infty}} =$ *Infinite*, by supposition; and this supposed Infinite would become 1, which is absurd. q. e. d.

Sch-

*Scholium.*

Taking the inſtance of the Indefinite quantity propoſed $\sqrt{\infty}\, 1 = \sqrt{1+1+1+1}$ &c. It's plain the root of any given number grows Greater or Leſs, as the number expreſſing or denominating the root is Leſs or Greater; and in $\sqrt{\infty}\, 1$, it's infinitely little root or $^{\infty}\sqrt{\infty}\, 1$ may be any finite Number greater than Unity as has been already ſhown; and its infinitely great root or $^{1}\sqrt{\infty}\, 1$ is Infinite. And between theſe Ly all the Indefinites that can be formed on 1 and $\infty$; to wit, $^{2}\sqrt{\infty}$, $^{3}\sqrt{\infty}$, $^{4}\sqrt{\infty}$, &c. and none of theſe can be properly called either, Finite or Infinite, but are in a perpetual Gradation towards either of theſe extremes, as the number that denominates the root grows greater or leſs; and they never become actually Finite, but when the number denominating the root is actually Infinite, nor actually Infinite, but when the Number denominating is *Unity*. And between theſe Two *Limits*, they are neither actually Finite not Infinite. Next to $^{1}\sqrt{\infty} = \infty$ (in order of the ſimpleſt Indefinites,) is $^{2}\sqrt{\infty} = 1 + \frac{1}{2} + \frac{3}{\infty} + \frac{5}{16} + \frac{35}{128}$ &c. wherein (by the quick encreaſe and greatneſs of the ſucceeding terms) the laſt becomes $\frac{1}{\infty}$ in a few Number, ſo to ſpeak, of theſe terms,

terms, where the series terminates, and so their sum $\sqrt[2]{\infty}$. becomes thereby less than $\infty$ 1. as will be more fully explain'd in the following Chapter, and in $\sqrt[5]{\infty}$ (for example) $= 1 + \frac{1}{5} + \frac{6}{50} + \frac{66}{750}$ &c. we see the terms of the Series converge yet faster, and will thereby terminate at $\frac{1}{\infty}$, much sooner. And so their sum $\sqrt[5]{\infty}$ will be much less than $\sqrt[2]{\infty}$. And for these (even when they rise to fractional Exponents whose Numerators are greater than 1, Such as $\infty^{\frac{2}{3}}$. $\infty^{\frac{3}{4}}$. $\infty^{\frac{4}{5}}$. &c.) an *Arithmetick* may formed, according to the example laid down in the *Scholium* of the precedent Proposition, with this addition, that an Indefinite as $\infty^{\frac{q}{p}}$ or $\sqrt[p]{\infty^q}$ multiplyed by another Indefinite $\infty^{\frac{r}{s}}$ gives the Product $\infty^{\frac{q}{r}+\frac{r}{s}}$ which becomes Infinite, when $qs + pr$ is $=$ or $< ps$ and Indefinit when $qs - pr$ is $=$ or $> ps$. And if an Indefinite as $\infty^{\frac{q}{r}}$ be divided by an Indefinite, as $\infty^{\frac{r}{s}}$ the Quotient $\infty^{\frac{q}{p}-\frac{r}{s}}$ is Infinite, when $qs - pr$ is $=$ or $< ps$ but is Finite when $qs - pr = o$ and only Indefinite, when $qs - pr > ps$. as it

it ought to be according to the Arithmetick of Surds.

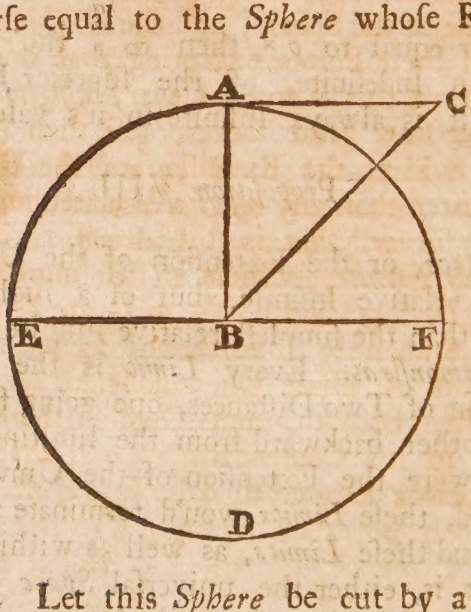
*N. B.* That in expreſſing an Indefinite by $\infty \frac{q}{p}$ it is always ſuppoſed that the Number $q$ is leſs than $p$, for if $q$ be either greater or equal to $p \times$, then $\infty \frac{q}{p}$ tho' it may be an Indefinite, of the ſuperior Degrees, yet it is always Infinite in it's value.

## *Propoſition* VIII.

*Space*, or the Extenſion of the Univerſe, is a relative Infinite, but of a higher Degree than the ſimpleſt relative Infinite $\infty 1$.

*Demonſtrat.* Every *Limit* is the Termination of Two Diſtances, one going forward, the other backward from the limiting Point, and were the Extenſion of the Univerſe limited, theſe *Limits* wou'd terminate a Space, beyond theſe *Limits*, as well as within them. That is, either the univerſal *Space* muſt be unlimited, and conſequently Infinite, or there muſt be *Space* beyond the Limits of univerſal *Space*, which is abſurd. Again, if the Extenſion of the Univerſe were limited any way, ſo as to become Finite, then a *Sphere* of a finite *Diameter*, might be found equal to it. For a *Cube* of a Finite ſide, may be found equal to any Finite *Content* what-

soever, as is well known, and the *Radius* of a *Sphere* equal to this *Cube*, is the *Product* of the *side* of the *Cube*, multiplyed into the *Cube Root of* $\frac{3}{2}$ *parts of the Ratio, of the Radius to the Circumference.* Let us suppose the whole finite Extension of the Universe equal to the *Sphere* whose Radius




is *AB.* Let this *Sphere* be cut by a *Plane* through it's *Center*, and the *Section* be the *Circle A D F E*, it is certain from the *Elements of Euclid*, that to any given Point *A*, a *Tangent AC* may be drawn, of which only the Point *A* falls upon the *Circle*; the rest of the Line *AC* falling without it. From whence it is evident, that there must be extension without this Circle, or the

*Sphere*

*Sphere* by the Section of which it is Generated. Since a *Plane* passing through this *Tangent*, and perpendicular to the *Plane* of this *Circle*, will only touch the *Sphere* in a Point; by which there will be an extended distance remaining between the *Circumference* of the *Sphere*, and the *touching Plane*, in all their Points excepting that one at *A*; And since this is true of every *assignable* Extension how great soever, less than Infinite. It is evident the Extension of the Universe is greater than any *assignable* Extension, how great soever, that is, by *Axiom* 1. it is *relatively Infinite*, which is still more evident from *Def.* 4. Since it's parts are Finite and their Sum only Infinite, and seeing this Infinite is of Three Dimensions, or as $\infty$ 1 in Height, Breadth, and Depth, therefore it must in it's Content be as $\infty^3$, that is, of a superior Degree to $\infty$ 1. q. e. d.

# Chap. II.

## *Of the PHILOSOPHICAL Principles of Reveal'd Religion.*

### *Lemma* I.

THERE is in all the Works of Nature, a *Symmetry*, and *Harmony*, running on in a perpetual *Analogy* (with proper Limitations arising from the different Circumstances of the several Parts) through the whole and the parts, or there is a *regular Connexion*, and *uniform Proportion* between similar Causes and Effects, a Congruity between the End and the Means. An Aptitude between the Faculty and it's Acts, and between the Organs and their intended uses, in the whole, and in the several parts of this *System* of things.

*Demonstrat.* This is evident from innumerable Instances already discover'd and ascertain'd. And every new Discovery in the most minute part of the Works of Nature, carries along with it a fresh *Demonstration* of this Proposition; one must be intirely ignorant of *Philosophy*, and *Mathematicks*, to want a Cloud of Witnesses to this Truth.

For

For Instance, the *sesquialter Proportion*, of the Periodical times of the Revolutions of the *Primary Planets*, about the *Sun*; and of the *Secundary Planets*, about the *Primary ones*; to their *middle Distances*, from the *Sun* and *Primary Planets* respectively, obtains universally. Their *Magnitudes*, *Gravities*, *Densities*, and their *Velocities* in their *Orbits*, in respect to, and about the *Sun*, and the *Primary Planets*, in the *Planets*, *Comets*, and *Satellits*, are in a regular and comely Proportion; the same *Gravity*, the same Law thereof, and the similar effects of both, obtains through the whole material *System* of things. The *Reflexions*, *Inflexions*, and *Refractions* of Light, are the same, in all the *Planetary* and *Cometary* Bodies and Regions; as they are on our Terrestrial Globe, with due regard to the different *Densities* of the *Mediums*. The *Circulation* of the *Fluids*, the *Manner*, and *Organs* of *Respiration*, and *Generation*, are *Analogically* the same in *Man*, *Brutes*, and *Vegetables*; with proper Limitations arising from the differing Circumstances of these Gradations of *Animals*. The *general Laws of Fluids*, *Elasticity* and *Gravity*, obtain in *Animal* and *inanimate Tubes*, but so far as they are alter'd in the first, by *Collateral* Causes. The whole of *Philosophy* and *Mathematicks*, is nothing but particular Instances of this Beautiful

*Analogy*, and the preceeding Chapters of the *firſt Part*, contain nothing but particular Inſtances thereof. And if we deſcend into the *Spiritual World*, we ſhall find this Beautiful *Analogy* preſerv'd, as far as the different Circumſtances of theſe Beings will permit. And if in this Demonſtration, it were allow'd to take in the Suppoſition of a *Being infinitely perfect*, who contrived and executed the whole, and the ſeveral Parts of this *Syſtem* of Things; it is impoſſible it ſhou'd be otherwiſe: A Being infinitely Wiſe, Simple, and One, muſt neceſſarily bring about Similar Ends by Similar Means, and perform all his Works the plaineſt, moſt Simple, and ſhorteſt way poſſible, due regard being had to the whole and the different Circumſtances of the ſeveral Parts. *Wiſdom in Things*, is their *Symmetry*, *Regularity*, and *Aptitude* for obtaining their deſign'd Ends and Purpoſes. The *Wiſdom* of a *Machin*, conſiſts in the due proportioning of the ſeveral Parts to one another, and to the whole, for obtaining it's propoſed End. *Diſproportion*, *Irregularity*, *Diſcord*, and the having no View or Deſign, are the ſureſt Proofs, and Indications, of Chance, Impotence, and Folly: A Wiſe Man performs all his Works, in Number, Weight, and Meaſure, and ſure *infinite Wiſdom*, *Simplicity*, and *Unity*, muſt accompliſh all it's Works, with the moſt

*Conſum-*

*Consummate Harmony, Proportion,* and *Regularity.* And this is the following Parts of this Treatise for Brevities sake, we shall call the ANALOGY OF THINGS.

*Lemma* II.

This ANALOGY OF THINGS duly instituted, is as certain a *Demonstration* of the *Existence,* and *Wisdom* of the Author of these Things, and of the Contriver of this *Analogy,* as also of the true Nature and Qualities of these Things discovered by this *Analogy,* as any *Mathematical Demonstration,* is of the Proposition proposed.

*Demonstrat.* No effect can be, without it's proper Cause, a wise and regular Effect must be produced by a wise and intelligent Cause, and an *infinitely Wise,* and *infinitely complicated* Effect, must necessarily imply an *infinitely Wise,* and *Omniscient* Cause. These are so certain and infallible *Axioms,* that I know not if in all the Compass of Humane Knowledge, any others come up to the same Degree of Evidence: And he can be no proper Subject of *Philosophy* or *Mathematicks,* who cou'd seriously deny them, since the whole Evidence of both these Sciences, suppose the first of these *Axioms,* and the rest are but like multiplying both sides of the same *Equation* by the same terms.

I have already observed, that the *Wisdom* of an *Effect*, or System of Effects, consists in the Proportion or *Analogy* of the several Parts to the whole and to each other, and of the whole, to the end propos'd; and that irregularity and no Proportion, is the surest Evidence of Want of Contrivance, Wisdom and Design. Now since the ANALOGY OF THINGS, just now Demonstrated, to be found in all the Works of Nature, in the whole, in every the most Minute Part: And in these, Instances of this *Analogy*, without Number, and without End. (Every new Step in the Knowledge of Nature discovering fresh Instances of this *Analogy*) all these, I say, do necessarily infer, an *infinity of infinitely Wise* Effects; and therefore these Effects, must as necessary infer the Existence of the *Author* of these Effects, and the Wisdom of the Contriver of this *Analogy*, as an Effect infers it's Cause; that is, as certainly as any *Mathematical* Demonstration infers it's Proposition; since it's certainty depends on the Connexion between Causes and Effects, and the Truth of this *Analogy* in general. I say in the next place, that the true Nature and Qualities of these Effects or Things, discovered by this *Analogy*, duly Instituted, may be as certainly concluded from this *Analogy*, as any *Mathematical* Demonstration, concludes

concludes its Propoſition. *Mathematicks* and *Philoſophy*, ſo far as they are juſt and genuine, are but Branches of this *Analogy*. *Mathematicks* are but this *Analogy* apply'd to *Figures* and *Numbers*. *Philoſophy*, properly ſo call'd, is but this *Analogy* apply'd to Bodies, or *Syſtems* of theſe; or to the abſtracted Natures of Things. Both, ſuppoſe the Truth and Neceſſity of this *Analogy*, without which they are but *Jargon* and *Romance*. An Inſtance or Two will make the whole Matter clear. Suppoſe it were required, to find the *refracted Ray*, when the *refractive Powers* of the Two *Mediums*, with the Inclination of the *incident Ray* on the *incident Plane*, are given. Let us borrow a *Corollary* from this *Analogy* of Things, to wit, that the diſtance between any fix'd Point in the *Incident*, and another in the *refracted Ray*, (the *refractive* Powers of the Two *Mediums* being regarded,) is the ſhorteſt poſſible; and with this *Corollary*, make an exact Computation; we ſhall then find the *refracted Ray* preciſely the ſame with that found out, from other different Principles and Methods (ſuppoſe of *Trigonometry*) where this *Corollary* has had no place, as the *Geometers* have ſhown. This *Phyſical Demonſtration* of this particular property of Light, (to wit, that in all *Incidences*, the *Sine* of the *Angle* of *Incidence*,

is

is to that of *Refraction*, in a constant *Ratio*) arising from this *Analogy*, is as certain a Proof of the Existence, and Wisdom of the *Contriver* of this *Analogy*, as also of the true Nature of Light, (as to this particular property) as any *Mathematical* Demonstration (suppose that by *Trigonometry*) is of the true Nature of the *incident* and *refracted Ray*. For who but an *omniscient Artificer*, cou'd contrive Light so? That among all the infinitely different possible ways, between Two assign'd Points, it shou'd single out that one, which is the shortest? And it is certain that the *refracted* Ray, is as truly found out by Virtue of this *Analogy*, as by any other more *Geometrical* Method. Another Instance may be taken from the regular and harmonious Progressions of *infinite Series's*; for Example, in the Powers of the *Binonimal Root*, $\overline{a+y}|^n = a^n + n a^{n-1} y + n \times \frac{n-1}{2} a^{n-2} y^2 + n \times \frac{n-1}{2} \times \frac{n-2}{3} a^{n-3} y^3$ &c. or the *Series* produced by Division $\frac{1}{1-n} = 1 + n^2 + n^3 + n^4$ &c. In a Word, every particular *Problem* in *Algebra* and *Geometry*, might be brought as Instances of this beautiful *Analogy* of Things, and those who are conversant in the more abstruse Speculations of *abstract Geometry*, can furnish themselves with Instances, so

surpri-

ſurprizing and extraordinary, of the Conſtancy of Nature in this beautiful Harmony, and comely Proportion, even in the largeſt Computations and moſt complex Conſtructions, as far ſurpaſs theſe Inſtances I have brought. Now what but an infinitely wiſe Being, cou'd have conſtituted the *Intellectual Species* of Things, ſo admirably? That all the Terms of theſe Progreſſions ſhou'd thus go on in ſuch regular and harmonious Proportions that every ſucceeding Term ſhou'd be made up of the preceeding ones, modify'd after one conſtant way, that by the caſt of an Eye, the ſaid ſucceeding Term ſhou'd be aſſign'd? whereas they might have been ordered, other infinitely different ways, ſo as to have afforded no regular Progreſſion. And does not this *Analogy* and harmonious Progreſſion of theſe *Series's*, as certainly give the ſucceeding Terms, as the actual Operations of *Algebra* do? Many more, and yet infinitely more ſurprizing Inſtances of this beautiful, *Analogy* and of the Inferences drawn from thoſe aſſign'd, might be given. But theſe may ſuffice for an Illuſtration of this *Lemma*.

*Lemma* III.

The Rules which ſeem naturally to ariſe for the due Inſtitution of this *Analogy* of Things,

Things, may be reduced to these Three, 1. That the Quality, Property or Idea, on which the *Analogy* is Instituted, be as simple and one, as possibly may be; and intirely the same, both in the known and unknown Subjects of the *Analogy*. Thus when we reason from the Nature and Properties of *Light*, and *Gravity*, on our *Earth*, to the Nature of *Light*, and *Gravity* in the *Planets* and *Comets*. We must separate these into their most simple *Ideas* and *Properties* (to avoid Confusion) as much as may be, and Institute an *Analogy* for each, to discover if the *Analogy* hold good in the complex, and precisely keep to the same *Properties* in the *Planets* and *Comets* the unknown Subject of the *Analogy*, as were supposed in the *Earth*, the known subject of the *Analogy*. Else we shall run into Confusion and *Paralogism*. 2. The necessary Limitations arising from the different Circumstances of the Two Subjects of the *Analogy*, as far as they may be known, must be cautiously and carefully taken into the State of the Question. Thus in the first Instance, assign'd in the Second *Lemma*, if the different *refractive Powers* of the Two *Mediums*, had not been precisely entered into the *Equation*, the Conclusion must have prov'd different from that found out by other Methods. Thus also in reasoning from the manner of *Generation* in *Animals* to that of

*Vege-*

*Vegetables.* If the Limitations ariſing from the different Circumſtances, and orders of Being, in theſe Two Subjects of the *Analogy*, be not carefully taken into the reaſoning, the Concluſions muſt prove falſe and erroneous. 3. Both the Subjects of the *Analogy* muſt be known and examined into, as far as may be, in regard to the other Qualities different from thoſe, the *Analogy* is inſtituted upon: But eſpecially the known Subject of the *Analogy* muſt be as fully known as is poſſible, in regard to thoſe Properties, on which the *Analogy* is inſtituted. Thus the more fully we underſtand the Nature and Qualities of our *Globe*, eſpecially as to *Light* and *Gravity*, and of the *Comets* and *Planets* as to their other Qualities, the more full and perfect ſhall our Concluſions be in regard to theſe aſſign'd Qualities, in the *Planets* and *Comets*: The more fully we underſtand the Circulation of the Fluids in *Animals*, the more aptly ſhall we apply them to *Vegetables.* Theſe Rules duly obſerved will render the Concluſions drawn by Virtue of this *Analogy of Things*, as certain as any *Mathematical* Demonſtration whatſoever.

*Propoſition* IX.

The *Viſible*, *Intellectual*, and *Created Species* of Things, are Pictures, Images, and Repreſentations, of the *Inviſible*, *Architypal*, and

and *Increated Species* of Things in the Mind of the supreme Being.

*Demonstrat.* This is evident from *Lemma* 1. and 2. For since it is certain, that there are to be found in all the Works of Nature a beautiful Harmony, a comely Proportion, and an exact Symmetry running thro' the whole. And since this *Analogy of Things*, necessarily infers the Existence of the Author of these Things, and the Wisdom of the Contriver of this *Analogy*. These Things and this *Analogy*, cou'd come from nothing else but from their original *Ideas* and *Architypal Patterns*, in the *Divine Mind* or *Imagination*, and their Harmony and Proportion, can possibly arise from nothing but their being Representations of his *Ideas*, who is omniscient, and does every thing in *Number*, *Weight*, and *Measure*. There being no other possible way they cou'd be contrived; and he being *Supreme* and *One*, cou'd find nothing without himself that they should represent. Besides, it is absolutely impossible, that infinite Power and Perfection, shou'd bring any thing into Being, that had not his own *Signature*, Stamp, or Image on it, for there cou'd be nothing besides *himself*, whose Images they shou'd be; and it is absurd to imagine they shou'd represent nothing at all. Therefore of necessity, they must be Pictures, Images, and Representa-

tions

tions of their *Ideas* and original Patterns, in the Mind of the Supreme Being. q. e. d.

*Corollary* I.

Hence it is evident that the *Visible*, *Intellectual*, and *Created Species* of Things, are Images, Pictures, and Representations of the *Divine Attributes*, more or less perfect, according to their Order in the rank of Beings. For since they are Images of the *Archytypal Ideas* in the *Divine Mind*, or *Imagination*, and since there was nothing without him, to beget these *Ideas*, and Nothing but his own infinite Perfections, that cou'd represent themselves to him, in order to make these *Ideas* arise in his Mind. Therefore of necessity, they must represent his *Attributes* or *Perfections* the only thing he cou'd have to copy out.

*Corollary* II.

Hence it is evident, that with proper Limitations arising from the *Infinitely-infinite* distance; (so to speak) between Finite and *absolute Infinite* we may reason *Analogically* from the Nature and Attribute of the *Supreme intelligent Being*, to the Nature and Properties of *Finite intelligent Beings*; and from these to those; to wit, by supposing these

these last Images, Pictures, and Representations at an infinite Distance of the first.

## *Proposition* X.

A *Mathematical* Point, and infinite Space are the Two *Limits* of natural or created Things, as to Quantity or Extension, in Ascending or Descending from Finite. And neither of them is any Part or Multiple of the other.

*Demonstrat.* This is evident from *Prop.* 8. for natural or material Things can have no more Dimensions than Three, and therefore the biggest Extreme in Created things, can rise no further by the *Analogy* of things than to $\infty$ raised to the Third Dimention. And since infinite Space is as $\infty^3$, therefore infinite Space is the biggest Extreme, or Limit of natural Things ascending from Finite. And since a *Mathematical* Point is the surface (so to speak) of the Extremity of a *Mathematical* Line, which has but one Dimension, it must of necessity be the least Extreme, in descending from Finite: In a Word, we can rise no higher in natural and material things than infinite Space, since that is the *Locus Universalis* of all created Beings. And we can descend no lower than a *Mathematical* Point, since every thing below it (if possible) cou'd have no place at all, or wou'd be no where, that is, wou'd be absolute Nothing. And

neither

neither of them can be any Part or Multiple of the other, since no number of Points, no not even an infinite Number, can make any real natural Quantity, not so much as a *Mathematical* Line, therefore *&c.* q. e. d.

*Corollary* I.

Hence a *Mathematical Point* and *universal Space* are true and genuine Opposites in Nature, and in the *Analogy* of Things, and between these Two Ly all created finite Subsistences. No natural Thing can be bigger than *infinite Space*, and no natural Thing can be less than a *Mathematical* Point, they differ the most widely that natural Things possibly can, and have nothing common but *Entity*, and so are true and genuine Opposites.

*Corollary* II.

Hence in the *Analogy* of Things, *Matter* cannot be Infinite, in any sense of Infinite ascending from Finite. For since *Matter* is of those natural Things, that necessarily require all the Three Dimensions, were it Infinite, by the *Analogy* of Things, it wou'd necessarily be as $\infty^3$, that is, it wou'd be equal to infinite Space, but since the necessity of a *Vacuum* has been Demonstrated in

the first *Chapter of the first Part*, it cannot be equal to infinite Space, and since it cannot be Infinite any wise but as infinite Space, by the *Analogy* of Things. Therefore *Matter* cannot be Infinite, in any sense of Infinite ascending from Finite.

## *Proposition* II.

*Absolute Nothing*, upon a real Quantity produces no Effect at all. Or *Absolute Nothing* can be susceptible of none of these *Arithmetical* Applications, to which, real Quantities are subjected.

*Demonstrat.* Suppose absolute Nothing upon a real Quantity, cou'd produce any Effect. Let the real Quantity be $a$ and the Effect $m$, then absolute Nothing $\times a = m$ that is, absolute Nothing is equal to $\frac{m}{a}$, that is, absolute Nothing is a real Quantity, as $\frac{m}{a}$ is, which is absurd. Now since absolute Nothing multiplyed into a real Quantity can produce no Effect, for the reason and by the Argument now assign'd, neither can it, when divided by a real Quantity, by the same way of reasoning, since Division by $a$, is the same with Multiplication by $\frac{1}{a}$. And since, Multiplication and Division are the same

ſame with Addition and Subſtraction reiterated as often as the Multiplicator and Diviſor implies: Therefore *abſolute Nothing* is ſuſceptible of none of thoſe *Arithmetical* Applications that real Quantities are ſubjected to. q. e. d.

*Corollary.*

*Abſolute Nothing* therefore, when apply'd to real Quantities by Multiplication and Diviſion (and conſequently, when by Addition and Subſtraction) implies, that there is neither Product nor Quotient, *that is*, that the real Quantity is neither Multiplied nor Divided, but remains unaltered.

*Propoſition* XII.

In the *Analogy* of Things; as a *Mathematical Point* is to *univerſal Space*, ſo is *abſolute Nothing* to the *abſolute and ſupreme Infinite.*

*Demonſtrat. By Prop.* 10. a *Mathematical Point*, and *univerſal Space*, are the Two *Limits* of material or natural Things: they involve ſimple, clear, and diſtinct Ideas, and are as well known, as any of the Objects of Human Knowledge. *Abſolute Nothing* is one of the Limits of the *Univerſitas rerum omnium*, to wit, that in deſcending, be-

low which nothing can fall; and therefore by the Rules laid down, for the *Analogy* of Things, the *absolute* or *supreme Infinite* must be the other Limit, beyond which nothing can rise in Ascending, and between these Two, all *Subsistences*, Finite, Indefinite, and relative Infinite are concluded. Wherefore by *Lemma* 3. and *Prop.* 9. as a *Mathematical Point*, *&c.* q. e. d.

*Corollary* I.

Hence *absolute Infinite* can neither be encreas'd nor diminish'd. For *absolute Infinite* and *absolute Nothing* being the *Limits* of all Things whatsoever, *absolute Infinite* must be the greatest of all Things, and so can neither be encreas'd nor diminished, else it cou'd neither be the *Greatest*, nor the ascending *Limit*.

*Corollary* II.

Hence *absolute Infinite* is *One*, and *Individual*. Because being neither capable of encrease nor diminution, and being the ascending *Limit*, it must be One: And Individual, because there can be no other like it, it being the One ascending *Limit*.

*Corol-*

*Corollary* III.

Hence *abſolute Infinitude* is only compatible to the Divine Nature, and to nothing elſe. He being the greateſt of all Beings, *One*, and *Individual*, or the ſingle poſſible Being of the ſame Nature.

*Corollary* IV.

*Univerſal Space*, is the Image and Repreſentation in Nature, of the *Divine Infinitude*, for ſince by *Prop.* 9. the created *Species* of Things are Images of the Increated, and by *Prop.* 10. *univerſal Space* is the *greateſt* Limit of the viſible Creation, or material *Syſtem* of Things. Therefore *univerſal Space* is the natural Image of the greateſt Limit of all Things, or of the *Univerſitas rerum omnium.* That is, by *Prop.* 12. and the *preceeding Corollary*, *univerſal Space* is the natural Image of the *Divine Infinitude*.

*Corollary* V.

Hence *univerſal Space* may be very aptly called the *Senſorum Divinitatis*, ſince it is the Place wherein all natural Things, or the whole *Syſtem* of material and compounded Beings, are preſented to the *Divine Omniſcience*.

*niscience.* Infinite Space is the Image of the *Divine Infinitude*, wherein as in a Picture of Him (in whom all things Live and move and have their Being) all created Things present and manifest themselves to, the intuitive View of the *supreme Infinite*, and therefore in the *Analogy* of Things, Infinite Space is to the *supreme Infinite*, what a Humane *Sensorium* may be supposed to be to Men.

*Corollary* VI.

An *absolute infinite Creature* is a Contradiction, because *absolute Infinite* is *One* and *Individual* by *Corollary* 2. of this.

*Scholium.*

One very remarkable difference between *Finite*, *Relative and absolute Infinite* is this. *Finite* may still be encreas'd by it self, and yet continues it's finite Nature, 'till the Number of Additions be actually Infinite. *Relative Infinite* may be encreased, not by Finite, but by *it self*, and still continues it's Nature, after *Infinitely-infinite* Additions, without Bounds or Limits: For let it be ever so often encreas'd by it self, it continues but *relative Infinite*. But *absolute Infinite* can be encreas'd by nothing, not even by

by it ſelf, elſe it cou'd not be the abſolute or greateſt Infinite. In natural Things *finite*, and *relative Infinite* never riſe higher than the Third Power. The *Comets* and *Planets* move in *Orbits*, that are *Curves* of the *Second Power*. *Projectiles* move in *Parabolick* Lines, which are of the ſame Order. The *Curvature* of the *Surface* of all the *Celeſtial* Bodies are of the *conical-Section-kind*. The *Surfaces* of Fluids, riſing in great or ſmall Channels, are of the ſame rank. Nature admits but of Three Dimenſions, and I know of no natural Effect, that riſes higher than the Third Power. Even the *irrational Curves* that Nature forms, in conducting *ſolid Bodies*, and the *Rays of Light* (thro' different *refracting Mediums*) the ſhorteſt and eaſieſt way: And in ſome other of her Operations, ſuch as the *Cycloid*, *Conchoid*, *Catenaria*, *Velaria*, *Curva Elaſticitatis*, *Logarithmica*, the *Spiral* and the like, all of them are of the loweſt rank of their Order: And their Natures imply only Portions of *Curves*, or of their *Areas*, of the *Conical-Section-kind*, the loweſt Order of all *Curves* whatſoever. So true it is that Nature perpetually brings about her Purpoſes *the ſhorteſt and ſimpleſt way*, and keeps conſtant to this beautiful *Analogy* of Things. But ſince Quantity may be ſtill encreaſed, ∞ may be ſuppoſed to riſe to higher Powers than

$\infty^3$ in the intellectual *Species* of Things, such as are, $\infty^4$. $\infty^5$. $\infty^\infty$. $\infty^{\infty^\infty}$ &c. Now tho' these Powers of $\infty$ superior to $\infty^3$, can have no Place in natural Things, or the material *System*, yet are they the *intellectual Species* of created Things, and are in their respective Orders, *Images*, and Representations of their *Architypal Ideas*, in the Divine Mind, and Instances of the unexhaustible Store, of manifold Wisdom, in the Divine Nature. And as *infinite Extension* is the Image in Nature, of *absolute Infinite*, so $\infty^{\infty^\infty}$ &c. is the Image of the same absolute Infinite, in the *intellectual Species* of Things. And by the *Analogy* of Things, relative Nothing, and relative Infinite are the *intellectual Images* of *absolute Nothing* and *absolute Infinite*, so universally does this *Analogy* hold good.

## *Proposition* XIII.

*Absolute Infinite*, in the *Analogy* of Things, is the precise and proper Opposite to *absolute Nothing*.

*Demonstrat.* This is plain from *Prop.* 12. and it's *first Corollary*. For since a *Mathematical Point*, is the precise and proper Opposite to universal Space, and since in the *Analogy* of Things, a *Mathematical Point* is to *infinite Space*, as *absolute Nothing* is to *absolute*

*abſolute Infinite*: Therefore *abſolute Infinite* is the preciſe and proper Oppoſite to *abſolute Nothing*. Beſides, *abſolute Nothing* and *abſolute Infinite*, being the *Limits* of the *Univerſitas rerum omnium*, in Aſcending or Deſcending from created Finite Beings. They muſt be preciſe and proper Oppoſites, having nothing common but their being *Entia and Limits*. q. e. d.

*Corollary* I.

Since *abſolute Nothing*, in it's poſitive *Idea* implies the utmoſt impoſſibility of, and the moſt extreme Contradiction to *reality* or real Being, as it moſt certainly does, for it is not poſſible to conceive a greater Contradiction to, or impoſſibility of *Reality* or real Being, than is imply'd in the poſitive Idea of *abſolute Nothing* or *Non-entity*, beyond which there is no further deſcending from Reality or Being. (It having no real *Entity*, tho' it may be claſs'd, as to it's negative Conception, in the *Category* of *Entia rationis*,) Therefore by the *Analogy of Things*, *abſolute Infinite* muſt imply in it's poſitive *Idea*, and that neceſſarily, the utmoſt poſſibility, and the moſt extreme neceſſity of *Reality* or real Being.

*Corol-*

*Corollary* II.

Wherefore since *absolute Nothing*, in it's positive *Idea* implies the utmost Contradiction to real Being, since *absolute Infinite*, is the precise Opposite to *absolute Nothing*, since also being Opposite in every thing (except as *Entia* and *Limits*, which do not effect the Realities in *absolute Infinitude*, as to it's positive *Idea*) *absolute Infinitude*, must imply in it's positive *Idea*, the utmost necessity of *Reality*, or real Being, therefore of necessity the *absolute Infinite* must really *Be*, or the Being to which *absolute Infinitude* is only compatible, must necessarily exist.

*Proposition* XIV.

*Finitude* and *Infinitude*, when apply'd to natural and created Things, in their positive *Ideas*, imply not *Realities*, but the *Modes* of *Realities*.

*Demonstrat.* *Finitude*, when apply'd to natural or created Things, imports only in it's positive *Idea*, the Proportions of the several Degrees of *Affections*, or *Properties* of these Things to one another. *Infinitude*, the unboundedness of these Degrees of *Affections*, or *Properties*. *Finitude* and *Infinitude*,

*tude*, in themſelves, abſtracted from a proper Subject or *Subſtantive*, are incomplete *Ideas* in natural or created Things. *Infinite Extenſion*, *Number*, *Duration*, *Wiſdom*, *Knowledge*, *&c.* are complete *Ideas*, whereof theſe *Realities* are the Subjects or *Subſtantives*, and the *Infinitude*, the *Epithet* or *Adjective*: Wherefore *Finitude* and *Infinitude* in natural or created Things, being but *Adjuncts* to *Realities*, in their poſitive *Ideas*, do not imply *Realities*, but the *Modes* of *Realities*. q. e. d.

*Corollary* I.

Hence the *Modes* of natural or created Things, are *Realities*, in the ſupreme or *abſolute Infinite*, or the *Modes* of natural or created Things, when *Analogically* elevated to the ſupreme, and *abſolute Infinite*, are in him not *Modes*, but the utmoſt *Realities*. This is plain from the *preceding Propoſition*, and the 2*d Corollary* of the 13. *Infinitude* is but a *Mode* in natural or created Things, but in the ſupreme or *abſolute Infinite*, it implies in it's poſitive *Idea*, the utmoſt *Reality*, to wit, neceſſary Exiſtence; and the ſame muſt of neceſſity be true, in all thoſe Attributes of the Divine Nature, which *Analogically* deriv'd down to the Creatures, are in them but *Modes*, in him

him they are the utmoſt *Realities*; becauſe they are all complicated and affected with, or (ſo to ſpeak) multiplied into *abſolute Infinitude*, which *realiſes* thoſe *Modes* of Creatures, and *Tranſubſtantiats* them into poſitive and *real* Qualities. So true is the *Metaphiſical Axiom, quicquid in Deo, ipſe Deus eſt.* I do not here contend that there may not be *acceſſory Ideas*, in the Divine Intellect, or that there may not *Arbitrarily* ariſe in the Divine Intellect, *Images* of Beings, whoſe Exiſtence is Fact, is not neceſſary. Since the *Idea* of a Creature, cannot be neceſſary to him, elſe they would neceſſarily be. But even thoſe *Acceſſory* or *Arbitrary Ideas*, in the Divine Imagination, by being there, become of a quite different Nature from the like in Creatures, for by being there, they (by Virtue of his *abſolute Infinitude*) receive a Being infinitely ſuperior to the like *Ideas* in created Beings, not neceſſarily, but with infinite Freedom and Liberty. And thoſe Affections and Properties in *Creatures*, which in them are but *Modes*, when *Analogically* carried up, to the like or ſimilar Affections or Attributes in the Divine Nature, are in him the utmoſt *Realities*, as being complicated with *abſolute Infinitude*, and thereby transform'd or exalted into real Quantities or actual Subſiſtences.

*Corol-*

*Corollary* II.

Hence, *Power*, *Subſiſtence*, *Duration*, *Knowledge*, *Wiſdom*, *Goodneſs*, *Beauty*, *&c.* which in created intelligent Beings, are the Images of *Omnipotence*, *Neceſſary Exiſtence*, *Eternity*, *Omniſcience*, *the Divine Sophia*, *Benignity*, *infinite Perfection*, *&c.* in the Divine Nature: And are but *Modes* of Being, and not eſſential affections in theſe, are in him infinite *Realities*, and living active Principles. And he that wou'd reaſon *Analogically*, from the Nature of theſe in created intelligent Beings, to the Nature of thoſe in the Divine Eſſence, without having the utmoſt regard to the *abſolute Infinitude*, which in a manner quite changes the Nature of the former, and exalts them into a different *Category*, wou'd be miſerably miſtaken. For Inſtance, he that, becauſe the Duration of natural Things is Succeſſive, wou'd conclude ſo of the Divine *Eternity:* He that wou'd reaſon becauſe humane Power cannot give Being and Subſtance to that which had none, the Divine *Omnipotence* cou'd not: He that wou'd infer, that becauſe the Knowledge of Rational created Beings is *Progreſſive*, the Divine *Omniſcience* were alſo Progreſſive, muſt be egregiouſly miſtaken: Becauſe in this *Analogy* he

he does not take in the *absolute Infinitude* which elevates and exalts the Duration Power and Knowledge of created Things, into a Degree of Reality of which these are but the Images or Pictures. He that from the Picture of a Man, wou'd *Analogically* reason about Humane Nature, from the blending and position of some Colours on Canvass, wou'd reason to Life, and Knowledge: Or from the reflected Image of the Sun in Water, wou'd conclude of Light, and Heat, cou'd not err more grosly.

*Scholium.*

In intelligent compounded Beings: The *Powers* belonging to the Body, are not only Finite, but very low in the Order of Finites. The *Eye* perceives not distinctly a very large nor small Object. Too strong a Noise stuns the *Ear*, and one too weak does not act upon the *Organ*: Neither of them produces a distinct Hearing; and it is so in all the other Senses. Those *Organs* are so contriv'd, as to perceive best the ordinary Effects of common Life, the Objects that necessity of Subsistence do most readily present to us. These they are fitted for, and little else; they have a wonderful Facility in manifesting these distinctly to our Minds, and have a just Proportion to the Objects

about

about us, but ſeem not contriv'd nor deſign'd for Curioſity, or conveying much more Knowledge to us, than what the conveniencies of Life require: Elſe infinite Wiſdom and Power might have eaſily formed them ſo, as not to need thoſe help and aſſiſtances, which we are obliged to employ when we aim at any more particular Knowledge of the intimate Natures of the Things about us, than conveniency makes neceſſary or commodious. The *Faculties* belonging to the Rational Soul are likewiſe Finite, but of a higher rank of Finites than thoſe Powers belonging to the Body. The *Imagination* can paint a larger *Idea*, than the *Eyes* can ſee, and the *Memory* lodge a greater ſtore of Images, than all the Senſes can preſent at one time: And the Underſtanding can combine and disjoin theſe, and compare them many different ways: But ſtill theſe Faculties are but Finite in their *Capacity*. We can form no diſtinct Ideas of *Millions* of *Millions*, of a *Multiangular Figure*, or any *relative Infinite*, ſmall or great: The Imagination ſeems not able to contain theſe; there is no room on it, for ſo large Pictures. The *Memory* is the *Repoſitory* of the Images that have been framed on *Phantaſy*, and can go no further than it reaches; nay ſeldom or never contains more than a ſmall part of thoſe. The *Underſtanding* can work

no

no further than these two afford Materials; it's Works being to *Collate*, *Combine*, and *Garble* as it were, these Images and *Ideas* the *Imagination* and *Memory* present to it. All these are Limited, as the Senses are, tho' not quite so straightly, because the *Understanding* may variously combine those *Idea's* they have convey'd to the *Imagination* and *Memory*, and so encrease their Number: And the *Will* having no subject Matter to proceed upon, but as it is prepared by these prior Faculties, can go no further than those allow it. The Understanding may diversify these as far as their *Combinations* will reach, and the *Will* may pick and choose among these, but since it cannot *create* Objects for it self to work on, it must be Limited to the Images and *Ideas* on the *Imagination* and in the *Memory*. The *Will* I mean, as it is Faculty belonging to the *Rational Soul*. All these Faculties seem to have been originally design'd for Nothing but this *material World*, and the System of Things about us. They help us to no Notion or Conception of any sort of Beings distinct from *Matter*, but in so far as *Analogy* will bear us out, and even as to the *material World*, they seem fitted for little else, besides the grosser, more general and more necessary Knowledge of Things that are required for due Conveniency, or Subsistence,

ſiſtence, and ſhow but ſome of the groſſer *out-lines* of the real Natures of Things. Every thing that might violently entertain our Curioſity, or flatter our Vanity, as to the Knowledg of the Natures of Things: Seems to have been induſtriouſly conceal'd from us, and no Faculties to have been indulged us, for theſe purpoſes, leaſt they ſhou'd have withdrawn us too ſtrongly, from things of greater Moment to the end of our Being: Elſe infinite Wiſdom and Power had contriv'd them after a more perfect Manner, with a larger *Capacity*, and a ſtronger *Energy*. As to the Faculties of the *ſupreme Spirit*, (which is a third Part of intelligent compounded Beings) they moſt certainly are infinite in their *Capacity* and *Energy*, I mean they may be enlarged and encreaſed without Bounds or Limits, which by *Def.* 4. is to be relatively Infinite. Not only the *Acts* of theſe Faculties may be Multiplyed perpetually, but the *Capacity* and *Energy* of theſe, may be dilated and intended without Bounds or Limits. The *Perception*, the *Deſires*, the *Will*, (the Faculties belonging to the *ſupreme Spirit*,) are unlimited and boundleſs, fitted and deſign'd for *infinite Objects*. Theſe indeed are the firſt, *Principal*, and *Original* Faculties, belonging to all compounded intelligent Beings: By which they are made capable of Communicating with the

*supreme Infinite.* And next in order of Nature to the *supreme Spirit*, is the *Rational Soul*, whereby they are enabled to communicate with the *material World*: And to the Faculties of this *Secondary* Part of the Compositon, the Senses of the Body are the *Conduits*, and Conveyances, which make up the Third and last part of compounded intelligent Beings: In the due *Subordination*, the perfect *Harmony*, and perpetual *Concord* of these Three, with each other, the *Perfection* of these Beings does consist: In their *Discord*, *Confusion*, and *Rebellion* one against the other, their *Degeneracy*, *Corruption*, and *Fall*. It can be no difficulty to those who are acquainted with the *Analogy* of Things, to conceive how these several parts of compounded intelligent Beings are contain'd without Confusion or Contrariety in each other; in their Primitive and uncorrupted State: When they consider, that in Water is contain'd Air, in that *Æther*, in that Light, and perhaps in this last, a more subtle and refin'd *Spirit*; and all these in perfect *Harmony*, and *Concord*. But to consider these a little more particularly. The *Perception*, as it belongs to the *supreme Spirit*, must of necessity be a *passive* Principle, because it cannot create it's Objects, but receive those presented to it: That it is Infinite, is plain, because it's adequat Object is Infinite, and the

*supreme*

*ſupreme Infinite*: It being beſtow'd on intelligent Beings, in order to Communicate with the *abſolute Infinite*. The neceſſity of this Third Part of the Compoſition of the mention'd Rank of intelligent Beings ſhall be afterwards Demonſtrated; I proceed to conſider in a few Words, the Nature of ſome others of theſe Faculties, belonging to the *ſupreme Spirit*.

*Propoſition* XV.

The *Deſire* is Infinite in it's *Capacity*, the moſt *Cardinal*, moſt *Quick*, and *Senſible*, and moſt *Active* Faculty of the *Mind* or ſpiritual part of compounded intelligent Beings, and the *Will*, and the *Affections* are but *Modifications* of it.

*Demonſtrat.* To be convinced of the Truth of this *propoſition*, we need only reflect on the Source of all the Happineſs or Miſery of intelligent Beings, and we ſhall find it ariſes from the enjoyment or diſappointment of their *Deſires*. There is in all intelligent Beings, a reſtleſs *Appetite* or *Deſire* of Happineſs: From the Moment of their Being, though all the Ages of Eternity, all their *Labour*, and *Travel*, is for this purpoſe: Nor are they devoid of it, either immediately in the *End*, or mediately in the *Means*, for one inſtant of time, in all their

endless *Duration.* Now this is the necessary Effect of the Faculty of *Desire*, no Object less than *Infinite* can satisfy it. For let it be supposed to have come to the Possession, of any Object less than *Infinite*, it's plain, it can *desire* yet a greater, and a greater, without Bounds or Limits; that is, it can desire an *infinitely great Object*, that is, the *Desire* it self, is infinite in it's *Capacity*; it's *Acts* are *Instantaneous*, and it's Enjoyments or Disappointments, for a time, swallow up the *Acts* of all the other Faculties: And therefore it is the most *Quick* and *Sensible*: It sets all the Powers of the whole Composition on Action, to obtain it's *Ends*, and therefore it is the most *Active:* And upon all these Accounts, the most *Cardinal* Faculty of the *Mind:* Chooſing or refusing, that is *willing*, is but the Desire apply'd to a particular Object; the *Affections*, are but the *Complexions* of the *Desire*, as apply'd to this particular Object: And therefore are both but *Modifications* of the *Desires*, wherefore, *&c.* q. e. d.

*Scholium.*

To apprehend how infinitely Capacious, Active, and Sensible the Desire is, we need only imagine our selves, separated from the Objects of Sense, and the present *Amusement* of

of *Life*, with all the Faculties of the Soul *awake*: And we ſhall then be able to conjecture, how *Strong*, *Active*, *Reſtleſs*, and *Unſatiable*, our Deſires wou'd be. So as to ſwallow up, and extinguiſh, all the other *Acts* of the Faculties of the whole compound. Thoſe only can moſt ſenſibly feel the force of this reaſoning, who have in ſome meaſure, and for ſome time been in this State.

*Corollary* I.

Since the *Deſire* is *Infinite* in it's Capacity, and may be dilated beyond any finite Object, how great ſoever, it is evident it cannot be over-fill'd, or ſuper-abundantly (ſo to ſpeak) ſatisfied, with any Object leſs than *Infinite*: Since alſo, the greateſt relative Infinite, cannot be aſſignable by *Corollary* 1. *Prop.* 1. Therefore the *Deſire* cannot be adequally and over-fill'd with any leſs Object than the *abſolute Infinite*; it being capable of being enlarged, beyond the Dimenſions of any *relative* or *creaturely Infinite* aſſignable: And ſince by *Corollary* 6. *Prop.* 12. no *Creature* can be *abſolutely Infinite*, therefore the Deſire can be perfectly and adequatly fill'd and ſuper-abundantly ſatisfyed, by nothing leſs than the *ſupreme* and *increated Infinite*.

*Corollary* II.

Since the *Desire* is *Infinite*, when fill'd and satisfied with it's proper and *adequat Objects*, it must be infinitely Happy; for since nothing, by the *preceeding Corollary*, but the *absolute* and *increated Infinite*, can adequatly fill, and super-abundantly satisfy it. The *absolute* and *increated Infinite* must be it's proper Object, and the *Desire*, *infinite* in it self, fill'd and perfectly satisfy'd with it's proper Object, the *supreme* and *increated Infinite*, must of necessity be infinitely Happy. Happiness arising from the *Congruity*, of the Object with the Faculty, and this *supreme* and *increated Infinite* being the proper and indeed the only proper Object, (since the supreme Infinite is One) it must alone be the *Congruous* Object, and so the Faculty being *Infinite*, the Object *Infinite*, and they infinitely *Congruous* to one another. The *Desire*, in the Possession or Enjoyment of this Object must of necessity be infinitely Happy.

*Proposition* XVI.

In regard of *intelligent Beings*, every thing that is in the *Universitas rerum*, may be fully comprehended, under these Three general

general Heads, to wit, the *Faculty* or *Desire*, the *Object* of this *Faculty* or *Desire*, and the *Sensation* arising from the *Congruity* or *Incongruity* between these two.

*Demonstrat.* All the distinct Subsistences that actually exist, are comprehended under these two general Heads, the *supreme* and *absolute Infinite*, and the *Creature*, and these can only be Objects of the *Faculty* or *Desire*. The *Faculty* or *Desire* being Infinite, by the *preceding Proposition*, may contain or receive both these, and the *Sensation* arising from their *Congruity* or *Incongruity* to the Faculty, must together with these two general Heads mention'd, comprehend every thing in the *Universitas rerum* in regard to any particular intelligent Being. For nothing can be Imagin'd in the whole extent of Being, *Real* or *Intellectual*, that may not be reduced to *Faculty*, *Object*, or *Sensation* arising from these. Therefore, *&c.* q. e. d.

## *Proposition* XVII.

An *Intelligent Being*, compounded of a Body, Soul, and Spirit, with proper Relations, and in Subordination to each other, is a real *Epitome*, *Image*, or *Representation*, of the *Universitas rerum omnium*.

*Demonstrat.* This is so evident from the *Analogy* of Things; that there can be no

difficulty in it, to those who will consider, that the *supreme Infinite* cou'd have nothing more perfect than Himself and his other Works, and his own perfect Administration and Government of these; to form this compounded Being upon. He must be consistent with Himself, and his *compounded Works*, in their component parts, must resemble in the *lesser* Compositions, the *similar* parts of the *Greater*. This *intelligent compounded Being*, being to have a *material* part, what can it have more worthy of the Work of infinite Perfection, than his *greater System* of material Beings to resemble? His Soul or rational Part can resemble nothing more worthy of *Him*, than the other higher Orders of created Spirits: And his *supreme Spirit* or Mind, will bear it's best resemblance, when it represents the *supreme Infinite*. His Administration and Government of the whole *System* of created Beings, can be represented by nothing so aptly, as the Relations and Subordination of these to each other, and to the rest of intelligent Beings, which these cou'd only be formed upon. In a Word, it is impossible that any *Idea* of a compounded intelligent Being, made up of several parts, each *Similar* to some greater part of the *Universitas rerum*, already existent, cou'd enter to the divine Mind, which cou'd be

more

more perfect and more worthy of *Him*, than this, that each inferior part ſhou'd be an *Epitome* and Reſemblance of his Works already made, and the higheſt part, of *Himſelf*, and that their Relations and Subordination, ſhou'd reſemble his Adminiſtration of the whole. I ſay it is impoſſible it ſhou'd be otherwiſe, to preſerve his Conſiſtency with himſelf, and to carry on this *Analogy*, through every individual part of his Works, through the whole *Scale* of Beings, as it moſt certainly is carried. And this is not a meer *Metaphorical* Picture, and Reſemblance, but the real and Phyſical Nature of compounded intelligent Beings. Wherefore, *&c.* q. e. d.

*Corollary* I.

From this Foundation, by a proper *Analogy*, with the due Limitations; all the *Relations* and *moral Duties*, of *intelligent compounded Beings*, to the *ſupreme Infinite*, to *ſimilar intelligent Beings*, and to *themſelves*, may be eaſily deduced; for Inſtance, do we reſemble the *ſupreme Infinite*, in our *ſupreme Spirit*: Then as he is the firſt in *Order* of *Beings*, ſo is this part of our Compoſition, the firſt and moſt principal, in our *Order* of Parts. All the reſt muſt be Subſervient and Subordinat in us, to this, as the

the rest of the several Ranks of Beings, are to him: This we are chiefly and mainly to Cultivate, by fitting it up for him, for whom it was *originally* design'd and bestow'd upon us. Here, we must aspire after *Him*, and open our *Desires* for *Him*, by a *Love* worthy of *Him*, superior Infinitely, to all our other *Loves* and *Desires*: On this part and it's Faculties, our Greatest, our Chief, nay, and our only Labour is to be bestow'd; that it may be Expanded, Dilated, and Elevated, to it's proper Rank in the *Order* of our Parts; that the due Subordination may be restored; which done, all the other Parts will perform their proper *Functions*, in *Harmony* and *Concord*. In regard to other *intelligent Beings*, we are to consider them, as like *Images* of *Him*, and *his Works*; and follow them with a *Benevolence*, proper to such *Images*, to imitate his Conduct of *Love* and *Forbearance*, to all his Creatures. But this only by the by.

## *Corollary* II.

Hence, in a proper *Analogy*, the Nature of the *Spiritual*, and *Material* Parts of compounded intelligent Beings and of the *Union* between these, as far as they may be known by meer Humane Reason, is to be deduced. Compounded intelligent Beings, are *Epitomes*,

or

or *Images* of the *Universitas rerum.* In their Bodies, they resemble the *material System* of Things, in their *Spiritual Parts*, they resemble the Spiritual World, the Union of these two is a resemblance of, (or is maintain'd and preserv'd after,) the Manner, the *supreme Being*, governs the *material System* of Things: Who being intimately present, with every individual *Atom* of Matter, yet more *eminently* acts from his superior *Throne of Glory*, having the whole *System* of Creatures, in one View presented to him, in the *universal Space*, his special *Sensorium.* By this Principle, as a *Key*, the whole *Phyloſophy*, of Humane Nature, of the Animal, Rational, and Divine Life, of the Passions, and Affections of the Soul, and even of the *Organiſm* of the Body, so far as it is Just and Genuine, and given to meer Humane Reason to know, is to be unlockt, and that not *Metaphiſically* but *Phyſically* and in Reality. But who is sufficient for the detail of these Things?

*Corollary* III.

Hence, the *Immortality* of the spiritual Part, of intelligent compounded Beings, is evidently to be deduced. For since the *spiritual* Part, of intelligent compounded Beings, is an *Epitome*, and *Image* of the *spiritual*

*ritual World*; and the *supreme Spirit* (that part which God *originally Breath'd* into Man) is an *Epitome*, and *Representation* of the *absolute Infinite*; since by *Corollary* 2. *Prop.* 13. he *necessarily* exists, therefore the Soil, or *spiritual* Part (whereof this supreme Spirit is the *Fund* or *intimate Substance*) must exist for *ever*. Not necessarily, for that Conclusion, wou'd drop the proper Limitation, in the *Analogy*, arising from *absolute infinitude*: But, as being *Images* of him, who exists *necessarily*, and having their Being from him. Their *Immortality*, is indeed an active, *living Principle*, not of necessary, (but *deriv'd*) Existence. They are *Immortal*, as having represented on them, all his communicable Perfections; of which, *perpetual* Existence is one, tho' *necessary* Existence be not; that being contrary to *Creation*, or deriving a Being from another. *Immortality* in Creatures, is nothing but *perpetuity* of Existence, and if Existence at all be communicable to Creatures, *perpetual* Existence must be communicable: For Existence, being an *active*, *living Principle*, will of it self continue *Being* for ever, unless it be destroyed: Which is impossible, both from the *Immutability* of *God*, and the Nature of his own *Immortality*, of which this is an *Image*, or *Resemblance*. The *Immortality* of spiritual Creatures, is an *Emanation* from an *Image* of the

the divine communicable *Immortality*. And muſt reſemble every thing in it, but *neceſſity*, that being a Contradiction to it's being *deriv'd*. But in every other Circumſtance it perfectly reſembles the *Immortality* of the ſuperior Infinite, (as far as creaturely Properties can reſemble Divine Attributes) and ſo cannot poſſibly be deſtroyed: And this is the true ſource of the *Immortality* of all Creatures. It is true, this *Demonſtration* equally concludes the *Immortality* of all his other Works, ſince they are equally his *Images*, in a higher or lower Degree of Perfection: And without all doubt it muſt be ſo, *for the Gifts, and calling of God are without Repentance.* And this is the Genuine, and as the *Schools* call it, the *Apodeictick Demonſtration*, of the *Immortality* of all the Works of God, under ſome form or another, it is from their being his *Images* that their Immortality ſprings.

*Corollary* IV.

In the *Analogy of Things*, the *Deſire* being the *Cardinal* Faculty of the Soul, and *Infinite* in it's *Capacity*, is as the *Infinite Space*, to the *Divine Plenitude*: Which infinite Space, nothing created, can adequatly fill, but the divine *Plenitude*. And in this view, the *infinite Capacity* of the *Deſire*, may be conſidered as a *Boundleſs Void*, made

to

to receive some *Fleeting*, limited Parts or *Systems* of Matter, acting by established Laws, and in comely Order, upon one another for a while, but can never be perfectly fill'd, or adequatly repleniſh'd, but by the *ſupreme Infinite*: Who is preſent with, and repleniſhes every point of the great and *univerſal Void* of Nature.

*Scholium* I.

As in regard to intelligent Beings, the *Univerſitas rerum omnium*, is fully comprehended under theſe Three general Heads; the Faculty or *Deſire*, the *Object*, and the *Senſation* ariſing from the *Congruity* or *Incongruity*, between theſe. So the ſame *Analogy* with proper Limitations, is preſerved in the material *Syſtem* of Things. For anſwerable to theſe, we have in the *material World*, *Gravitation*, which wonderfully *Analogiſes* to the *Faculty* or *Deſire*, in the *ſpiritual World*, and this to that; both being the *Active*, *Cardinal*, and *Energetick Principles*, of either *Syſtems* reſpectively. Next we have a *Maſs*, of extended ſenſible Matter, if collectively conſidered, or *Syſtems* of *material Bodies*, diverſly figured and ſituated in regard to one another, if ſeparately conſidered: And in both theſe views, they admirably repreſent the Subject or Object of the

the *Desire*, which is Analogised by *Attraction* or *Gravitation*. And lastly we have the *Harmonious*, *Comely*, and *Decent* Motions, and Actions of one Body upon another, arising from the *Attraction* or *Gravitation's* being impress'd on the *Mass*, and each particular Body; and this too, answers wonderfully to the *Third* Principle in the *Universitas rerum*. And this *Analogy* descends even to particular Bodies, for in these we have the Form, the Subject Matter and the *Congruity* between these.

*Scholium* II.

From the whole proceeding Chain of *intellectual Truths*, we may form to our selves some *faint*, *low*, and *imperfect Image* or Representation of the EVER-BLESSED TRINITY IN UNITY. For since, by *Corollary* 1. *Prop.* 14. the *Modes* of natural or created Things, when *Analogically* elevated to their similar Attributes in the *supreme Infinite*, in *Him*, are infinite *Realities*. Since, by the *same Proposition*, an intelligent Being is, as to it's spiritual Part, an *Emanation* from, an *Image* and *Representation* of, the *supreme Infinite*: And since also, in regard to these intelligent compounded Beings, all that is in the *Universitas rerum omnium*, may be fully comprehended under these Three general Heads

Heads or Principles. The *Desire*, the *Object*, and the *Sensation* arising from the *Congruity* or *Incongruity* between the *Faculty* and the *Object*. Since lastly, this *Analogy* is preserv'd full and clear, through the *spiritual* and *material* Worlds, and each particular Body, that is, through the whole *System* of Creatures: It is highly probable, so constant, and universal an *Analogy*, can arise from nothing, but from it's *Pattern* and *Architype* in the Divine Nature: And without all peradventure, cou'd we fully and clearly carry it up to it's *Source*; we shou'd there find the *Origin* and *Source* of this HOLY TERNARY; or of these Three essential Relations, of the whole, to the whole in the completion of the GODHEAD. Let us therefore try, in some poor low manner, to carry up this *Analogy*, as high as possibly we can. The first thing then that we are to consider, in the Divine Nature is, the *Desire*, now this being supposed, to belong to a *supremely infinite intelligent Being*, must be an infinitely *Active*, *Ardent*, *Strong*, and *Powerful Thought*. And that, not as created, or *relative Infinitude* expresses it, but as the absolute and *supreme Infinitude* elevates this *Desire*. Now then this supremely Infinite *Desire*, this *Active* and *Ardent Thirst* after Happiness, or after a full, plenary, and compleat, Beatifying Object, we shall

ſhall ſuppoſe to repreſent the FATHER, the *Original* and firſt *Principle* in the Divine Nature: Seeing then, there is no conſideration here of any thing but of *God himſelf*, nor is it poſſible for any other Object, but *God himſelf* to ſatisfy, and adequatly to fill this *ſupremely infinite Ardor*, *Thirſt*, and *Deſire* of *Happineſs*. Therefore *He-himſelf*, reflected in upon *Himſelf*, viewing and contemplating his *own* infinite Perfections: The *infinite ardent Deſire*, fill'd and ſatisfy'd with his own eſſential Happineſs: The *brightneſs of his Glory*, and the *expreſs Image*, (the eſſential *Idea*,) *of his Subſtance*, reflected in upon *himſelf*: Or *God himſelf*, *reduplicatively* contemplating *Himſelf* (He having nothing elſe poſſible, to be the Object of his *Love*, *Delight*, or *Deſire*) repreſents to us the *Begotten Deity*, the SON, the ſecond Divine *Principle* in the Order of the *Godhead*. Upon this *reflexion*, *contemplation*, and poſſeſſion of *God-himſelf*, in *Himſelf*; there muſt of neceſſity ariſe, a *Joy*, *Happineſs*, *Acquieſcence*, and *Satisfaction* of *God-himſelf* within *Himſelf*, ſo much the more *Perfect*, *Full*, *Extreme* and *Infinite*, as his *Deſire*, *Thirſt*, and *Ardor* after Happineſs, was *Active*, and *Strong*. And this may ſhadow out to us the third and laſt, in Order, of theſe eſſential *Principles*, in this *myſterious Ternary*, to wit, the HOLY

GHOST. And tho' these three Relations, of the *Godhead* in it self, in regard to Creatures, and when deriv'd down *Analogically* to natural Things; may appear but *Modifications* of a real Subsistence, yet in regard to the *Divine Nature*, and considering his *supreme Infinitude*, they must be *essential*, and infinitely *real* and *living Principles*; and in this *Image*, and view of the HOLY AND UNDIVIDED TRINITY, *low* and *poor* as it is; It is impossible the SON shou'd be without the FATHER, or the FATHER without the SON, or both without the HOLY GHOST. It is impossible, the SON shou'd not *necessarily* and *eternally* be Begotten of the FATHER, or that the HOLY GHOST shou'd not *necessarily* and *eternally* proceed from both; *He* necessarily arising from the *Sensation* of the infinite Agreement and *Congruity* of the *Object* with the *Desire*. And tho' the *Idea Image*, or *Representation*, that *God* makes of *Himself* to *Himself*, be the same *God* in *Essence*, since it is a most perfect, express, and substantial *Image*, or *Representation* of the whole Divine Substance and Nature, and *necessarily* has in it, the whole, that is in *God*, and with the same infinite Perfections, that is really in the *Godhead*: Being only the *Divinity*, reflected in upon it *self*. Yet there is a difference, between the *Idea*, *Image*, and

and *Repreſentation*, and the *original Divinity*. For the ſame Perfections which are in the *original* and *contemplating Divinity directly*, are but *indirectly*, and by reflection in the *contemplated* and *Begotten Deity*; and they differ, by the *Relations* of *Begetting*, *Contemplating*, and *Repreſenting*; and being *Begotten*, *Contemplated*, and *Repreſented*: And tho' theſe be only *meer Relations*, and *Modifications*, when transfer'd to natural and created things, yet are they *infinite Realities* in the *Deity*. It is the ſame with the *Senſation*, of *Love*, *Joy*, *Acquieſcence*, and *Happineſs*, that ariſes in the *Divine Nature*, from *contemplating* and *poſſeſſing Himſelf* and his own infinite Perfections, within *Himſelf*. And theſe *three Relations*, of *Contemplating*, being *Contemplated*, and of *Acquieſcence*, ariſing from them: Which in a natural view, wou'd only be *Modifications*; Yet in the *Divine Nature*, are infinite *Realities* and *eſſential and living Principles*: And may ſerve as a faint and imperfect *Image* of THIS ADORABLE AND UNSEARCHABLE MYSTERY. Now tho' theſe views, and Repreſentations, of this INEFFABLE AND INCOMPREHENSIBLE MYSTERY, ariſe *naturally* and *neceſſarily* from the *Analogy* of Things, ſufficiently eſtabliſhed in the *preceding Propoſitions*; and without all doubt, have ſome *real Truth* in them; ſince it is certain, theſe

*Relations* and *Modifications* of Subsistence, are really in *intelligent Beings*, in the *material System* of Things, and in *particular Bodies*: And cou'd have no other *Rise* and *Source*, but from their *Pattern* and *Architype* in the *Divine Nature*. Yet when apply'd to the *supreme Infinite*, these relations and distinctions, must be express'd in Words, that have a quite different Sense affix'd to them, by common use, from what they shou'd here *import*: And since the *Attributes* and *Relations* of the *supreme Infinite*, must be *Incomprehensible* to *finite Creatures*, especially to *Creatures*, conversant only about low, gross, and material *Images*; all I wou'd be understood to conclude, from this *Analogy*, thus raised to the *supreme Infinite* is, that *Reason* may form an *Analogical* imperfect *Image* (and that's all it can do) of this INCONCEIVABLE MYSTERY, which may in some measure help those, (who have not attain'd to a more perfect Guide or higher Lights) to believe the positive Relations of his own Nature, by *God himself*, tho' they be not able, perfectly to comprehend or express them. And if this poor Representation, of so PROFOUND A MYSTERY, so *Certainly*, and FULLY reveal'd in *Holy Writ*, can by the *Divine Blessing*, any wise Contribute, to *settle* and *quiet* sober and honest Minds, I shall have my full

Intention.

Intention. Nothing leſs than *Omnipotence*, and *Omniſcience*, being ſufficient to deal with thoſe, who are otherwiſe diſpoſed.

*Propoſition* XVIII.

There muſt of neceſſity be ſome *Principle* of *Action* in intelligent Beings, *Analagous* to that of *Attraction* in the material *Syſtem*, and that is, the *Principle of Reunion* with the *ſupreme Infinite*, by him originally impreſs'd on their *ſupreme Spirits*.

*Demonſtrat.* That there muſt be ſome Principle of *Action* impreſs'd on intelligent Beings, *Analogous* to that of *Attraction* in the material *Syſtem*, is evident from the *Analogy of Things*, the Conſiſtency of the Works of the *ſupreme Infinite* with themſelves, the *Uniformity* conſpicious in all the Creatures, and that the material are but *Images* and *Repreſentations* according to their reſpective Natures, of the *ſupreme Infinite*, as well as of the intelligent *Syſtem* of Beings. There muſt therefore ſome *great Principle* of Uniformity, run thro' both *Syſtems*, that is, the whole Creation. Now that *Attraction*, or ſomething *Analogous* thereto, is the great Principle of *Activity* in the material *Syſtem*, has been ſufficiently Demonſtrated in the former Part of this Treatiſe. There muſt of neceſſity therefore, be ſome *great Princi-*

*ple Analogous* to this, in the *System* of intelligent Beings. And that this can be nothing, but that great *Principle of Reunion*, with the Author of their Being, originally impress'd on every intelligent Creature: Is evident from hence, to wit, that the *supreme infinite Being*, infinitely powerful, and perfect, must necessarily subject, draw, and unite all intelligent Beings to Himself, to make them as happy, as their respective Natures can admit. That Himself is the *Sole Object* of their Happiness can not be doubted, there may be collateral and accessory Objects of their Happiness, but even these must flow from him: But that he is the supreme Object, and the single one that can adequatly satisfy them, has been shewn before: That therefore, to bring them to this Happiness, he must impress upon, or derive to them, a *Principle of Reunion* with himself, is plain, because this is the single mean, to bring them to this end; for the known Law of Nature, obtains even here, and every where, to wit, that *Action and Reaction is Mutual*, so that if the *supreme Infinite* must draw them to him in Order to make them happy, they must have a Principle of being drawn towards him. That it must be a *radical* and *essential* Principle, is evident also, because this happiness is the very end of their Creation, it being impos-

impoſſible infinite Perfection ſhou'd make intelligent Beings, for any leſs or any other *End.* Wherefore the *ſupreme Infinite*, cou'd not make intelligent Creatures, without *implanting* in their Natures, a *moſt ardent Deſire*, an *eſſential* Principle, interwoven in the Subſtance of the ſpiritual Natures, of being re-united with Himſelf, in order to make them as happy, as their relative Natures will admit of. Beſides, intelligent Beings (as to their ſpiritual part) are Images of the *ſupreme Infinite* by *Prop.* 15. In him there is an *infinite Deſire*, and *Ardor* of poſſeſſing and enjoying Himſelf, and his own infinite Perfections, in order to render him happy, he himſelf is the *ſole Object* of his own, and of the felicity of all his Creatures. There muſt therefore be an Image of this his infinite Deſire after Happineſs in all his intelligent Creatures; and this Image, can be nothing but this *Principle of Reunion*, ſince nothing but this can unite them with him, to make them happy. Laſtly, an intelligent Being, coming out of the Hands of *infinite Perfection*, with an Averſion, or even Indifferency, to be re-united with it's *Author*, the Source of it's utmoſt Felicity, is ſuch a ſhock, and deformity in the beautiful *Analogy of Things*, ſuch a breach, and gape in the *harmonious Uniformity*, obſervable in all the Works of the Almighty,

and that too, in the noblest and highest part of his Works; as is not consistent with finite Wisdom and Perfection, much less with the *supremely infinite* Wisdom of the ALL-PERFECT. Wherefore, *&c.* q. e. d.

*Corollary* I.

Hence we may discover the Source, of *natural Conscience*, and of all those Motions and Convulsions, that are raised in the Breasts of compounded intelligent Beings, upon the *Commission* or *Omission* of certain Actions: Of that *Comfort*, *Joy*, and *Support*, in some; and of that *Dejection*, *Dread*, and *Terror* on the Minds of others; where no natural Causes can be assigned. Hence the *noble* and *sublime Discoveries* of the *antient Heathen Philosophers*, in the Principles of moral Virtues, without the assistance of Revelation. Hence it is, that *Scelerats*, can by no Arts, nor any Amusements how violent soever, stifle the Cries of a wounded Conscience; and hence also, it is, that honest and upright Minds, are sometimes swallow'd up, by a Tranquility and Peace that surpasses natural Understanding. That this *Principle of Reunion*, is defaced, buried, and in some measure as it were, obliterated, by contrary *Attractions*, by *Sensuality*, and the violent Amusements of Licentiousness in compounded

pounded intelligent Beings, is no more an Argument againſt it's *eſſentially* belonging to intelligent Beings, than the *Ideotiſm* of ſome is an Argument againſt the Principle of Reaſon in humane Nature. But

*Corollary* II.

From this *Principle's* being ſo *radically* implanted, in all the Individuals of intelligent Beings, and from the ſo very few Inſtances and Remains of it, conſpicuous in the humane Race; we may gather the infinite and univerſal Degeneracy, and Corruption, of this ſet of intelligent Beings, from their *Primitive* and *Original* Inſtitution. This Principle was moſt certainly implanted in their Creation, in the very *Fund*, and Subſtance of their Natures, and yet there remains but few Footſteps, and Inſtances of it's *Being*, or *Effects*. There are indeed (as in the Greater World) ſome *legible Characters*, *ſtrong Out-lines*, and *prominent Lineaments*, of it's original Beauty, ſome *magnificent Ruines*, which ſhow what it had been enough to Demonſtrate the *original Impreſſion*, Beauty, and real Being, of ſuch a *Principle*, in all the Individuals of this Race, as is evident from the *Pangs* and *Tortures* of *natural Conſcience*, when it is counter-acted. But the little effect it has, from

from what it was design'd to have, is an evident Demonstration of the deep and universal Corruption of this *Set* of intelligent Beings.

*Corollary* III.

Hence we may further discover, the Force, Truth, and Universality of this wonderful *Analogy of Things*, whatever we discover of the Works of Nature, is from this Source, and whenever we get the least *Glympse* into the manner of the Divine Operating, we discover fresh Instances of this *Analogy*. This *Principle of Reunion* in intelligent Beings, wonderfully *Analogises* with that of *Attraction* in the material World: As to the *supreme Infinite* it may be very properly called his *Attraction* of them, and as to them, their *Central Tendency* or *Gravitation* (so to speak) toward him; and this *Principle of Reunion*, if attended to, duly Cultivated, and Expanded, wou'd as certainly bring about, the Temporal and Eternal Happiness of all intelligent Beings, in the *spiritual World*; as that of *Attraction*, brings about the Comely and *Harmonious* Motions, of the *great Bodies* of the *material World*. This *Principle of Reunion* is the *original* Source and *Spring* of the *Desire*, afore Demonstrated, to be the

*Cardinal*

*Cardinal* Faculty of the ſpiritual Part of intelligent Beings. The *Principle of Reunion*, is the *Root* and Foundation of the *Deſire*, in regard to it's firſt Cauſe and original Impreſſion, by the *ſupreme Infinite*. This *Principle of Reunion*, as it is conſidered, as an infinitely *active*, *quick*, and *ſenſible* Faculty, in the ſpiritual part of compounded intelligent Beings, is the *Deſire of Happineſs*; as it is conſidered as a *Theological* Virtue, it is *Charity*; and as it is conſidered as a *Rule* of Action, it is *natural Conſcience*. But the *Principle of Reunion*, in it's whole extent, as it was originally impreſs'd upon, and quite interwoven with the intimate *Fund*, and Subſtance, of the ſpiritual part of compounded intelligent Beings, is the *Source*, *Origin*, and *Root* of all theſe.

*Corollary* IV.

Hence, the true and genuine Nature, of *Moral Good* and *Evil*, and of all the Moral Virtues, and *Social* Duties of Life; as from their genuine Fountain and Source, is to be derived. Whatever retards, or oppoſes this *Reunion*, in intelligent Beings, is to them *Moral Evil*; whatever promotes, or advances this *Reunion*, is to them *Moral Good*. Beſides, this *Principle of Reunion*, duly Cultivated, regularly Unfolded, and carefully

carefully Attended to, must necessarily produce and perfect in the Soul *universal Charity*; that is, the Love of the supreme Being, and of all his Images in a due Subordination; and thereby instruct, and beget in the Soul, all the *Moral* Virtues, and *Social* Duties of Life. All these, being *virtually* and necessarily included in *Charity*. But to explain this matter (which is of the utmost consequence towards a right Apprehension of *solid Religion*) a little further, I say

*Proposition* XIX.

*Charity*, or the Love of the *supreme Being*, and of all his *Images*, in a proper Subordination, according to their *Rank* in the *Scale* of Subsistences, is the necessary effect of this *Principle of Reunion*, when fully expanded, and set at freedom.

*Demonstrat.* By *Corollary* 4. *Prop.* 17. nothing but the *supreme* and *absolute Infinite*, can adequatly fill and superabundantly satisfy, the *infinite Desires* of intelligent Beings, the *Desire* in intelligent Being is their *Love*, for no intelligent Being can desire any in order to make it Happy, but what it *loves*; or can *love* any thing, but what it *desires* to enjoy, (*Indifference* being the middle State, and *Aversion* the equal

Opposite,

Oppoſite, both to *Love* and *Deſire*.) So that an infinite *Deſire* of the *ſupreme and abſolute Infinite*, is an *ardent Love* of that *Being*. But the *Principle of Reunion*, expanded, ſet at freedom, and arriv'd at it's *ultimate End* and *Center*, is intirely the ſame with the *infinite Deſire* in intelligent Creatures, poſſeſs'd of it's ſole and proper Object, the *ſupreme and abſolute Infinite*. Conſequently the *Principle of Reunion*, expanded, and ſet at freedom, in order to arrive at this *ultimate End* and *Center*, muſt *neceſſarily* beget, in the Spirits of intelligent Creatures, this *infinite Deſire* of the ſole and proper Object; that is, an *infinite Love* of the *ſupreme Being*: And by neceſſary conſequence, a *Love* of all his *Images* in proportion to their *reſemblance* of Him; that is, the *Principle of Reunion* when expanded, and ſet at freedom, muſt neceſſarily beget, in the Spirits of intelligent Beings, a *Love* of the *ſupreme Being*, and of all his *Images* in a proper Subordination, according to their *Rank* in the *Scale* of Subſiſtences, that is *Charity*. q. e. d.

*Corollary* I.

Hence, *Charity*, or the *Love* of the *ſupreme Being*, and of all his *Images* in a proper Subordination, in it's true and genuine

nuine Nature, is not founded on *Interest*, or the *views* of *Rewards* and *Punishments*; but altogether, on the *abstracted Perfections* of it's Object, the *supreme Infinite*. *Charity* in it's Origin, and as it ought to be, according to the true *Analogy* of Things, is a *Physical*, and necessary consequence of the *Principle of Reunion*: It flows naturally from an *implanted* Faculty, and has for it's Object the *supreme Infinite*, in his own *independent* and *essential* Nature, as he is *absolutely* Good, and Perfect, without any *collateral* Views or Regards. *Charity* is in a higher degree, and in a more noble Creature (one, to wit, endowed with freedom and liberty of Acting,) what *Motion* proceeding from the Principle of *Gravitation*, is in *Brute-matter*, or what the *Tendency* of the *Planets* is, towards the *Sun*, *viz.* a natural Consequence, of an implanted Principle. This is so clear and so certain, in true *Philosophy*, that it is matter of Astonishment to me, how it came once to be doubted, much less disputed. *Henry Moor*'s Argument on this Head, is as cogent and just, as any Demonstration in *Euclid* or *Appollonius*. "*As the Object of the Intellect* "*(says he) is that which is simply true,* "*and is assented to as such, and not as true* "*to this particular Intellect which contem-* "*plates it, so there is an Object that is*

"*simply*

" *ſimply Good and Lovely, and to be Lo-*
" *ved as ſuch, without regard to the Party*
" *that thus loves it.* And in another place, he uſes the familiar Illuſtration of *Ginger-Bread* and *Mathematicks*, wherein he grants the former, may be a Spur to the latter, 'till Age and good Senſe, with the Knowledge of the intrinſic Beauty and Worth of the latter, makes the *Student* in Love with the *Study* it ſelf, without any conſideration of the *Childiſh Bait.* As in natural Love, Perſons become often enamoured of *outward Beauty*, without any particular Knowledge of it's Poſſeſſor, or it's *attainableneſs* by them; ſo without all peradventure, *infinite Perfection* for it's own intrinſic *Pulchritude*, muſt be the proper Object of *Divine Charity*, without any particular regard to the Party loving it. Not that *Intereſt*, or a *View to Rewards* and *Puniſhments*, is not often the only Motive of *Divine Love*: And always is a very proper and *laudable* one, when *infinite Perfection* is the Object. And in reality, it is as high, as moſt of the *lapſed Race of Adam*, in their degenerate State can riſe to. But as things are in their *original Natures*, were in their *Integral*, and muſt be in their *reintegrated* State. *Infinite Beauty*, or Perfection, without any regard to *Self-intereſt*, or any view to *Rewards or Puniſhments*, is, was, and muſt

must be, the proper and sole Object of pure and perfect *Divine Love*, or *Charity*.

*Corollary* II.

Hence the *Service*, *Worship*, and *Homage*, we owe to the *supreme Being*, is founded intirely upon his own *original Excellencies*, and Perfections, and not on his *Rewards* and *Punishments*; there neither ever was, nor ever cou'd be, any room for *Contracts*, or *Pactions*, between the *supreme Being*, and his intelligent Creatures, in the original Constitution of Things. *He made all Things by the Word of his Power, and for his Pleasure they are and were created. Infinite Perfection* is to be *Lov'd*, *Admir'd*, *Ador'd*, and *Serv'd*, for being infinitely perfect *Antecedently*, and without any regard to Creatures: And when Creatures are brought into Existence, this *primary* Reason of *Love*, and *Adoration*, subsists, and in order of Nature and Dignity, is *prior* and preferable to all other Reasons. *Creation* adds nothing essential to *infinite Perfection*, but a *Circumstance* only, which too, intirely evanishes when brought into Comparison, with the original Beauty of the *absolute Infinite*. All his Creatures that act naturally, correspond, and are faithful, to the greatest exactness, to his *original Impressions*, and his appointed

ted and design'd Ends on them. The *Celestial Orbs*, the *Sun*, *Planets*, *Comets*, and *fix'd Stars*, those huge unweildy Masses of Matter, revolve in regular *Periods* and constant Order, by their impress'd Power of *Gravitation* and *Primitive Frame*. The *Vegetable Tribes* are faithful to his appointed Seasons. The *Brute Animals*, sacredly obey their *inbred Instincts*. Only his compounded intelligent Creatures, if they at all obey, do it for their own, not his sake, that is, they themselves are their own *ultimate End*, contrary to what was *Demonstrated*, *Corollary* 4. *Prop.* 17. It is true in the Nature of Things, it's absolutely impossible, to separate the *Duty* and *Felicity* of intelligent Creatures, their *Happiness* consisting, in their being in the *Order* of their Nature, that is, of GOD *it's Author*, and their only *Duty* being faithfully to obey this *Order*. Yet these Two may be considered apart, and *Mentally* abstracted the one from the other: And the last must be *Anterior* to, and in the Order of Things, must precede the former: So that when we invert this *Order*, and bring in our *Happiness*, as the sole *Motive*, or the preferable *Motive* to our *Duty*, we become guilty of the most *gross and blackest Idolatry*: For he who loves and worships the *supreme Being*, only becaufe his own *Happiness* is thereby

brought about, makes Himself and his own Happiness, his *ultimate End*, and so places himself in the *Rank* and *Order*, that belongs to GOD only, and himself becomes his own *Idol*. He only can be said truly to *Love* GOD, with a *Love* undivided, and worthy of him, who having *loved him*, as far as *Rewards and Punishments* will carry him, goes on still further to *love him*, looses all views of these *mercenary Motives*, and seeks for no Fuel to feed the *celestial* Flame, but the *unexhaustible Pulchritude*, and Perfections of the *beloved Object*.

### *Proposition* XX.

*Charity*, or the pure and disinterested *Love* of GOD and of all his *Images* in a proper Subordination is the *end of the Law*, the *Accomplishment* of all the *Graces*, and the consummate Perfection of *Christianity*.

*Demonstrat. On these Two*, to wit, *the Love of* GOD and *our Neighbour hang both the Law and the Prophets*, says the ADORABLE AUTHOR OF CHRISTIANITY, and the *Apostle* says, *the end of the Law is Charity*, if the *supreme Being* is the *ultimate* Object of the Felicity of all intelligent Creatures, and *Charity* the mean to attain this end, as is evident from the *preceding Proposition*, then is *Charity* the consummate *Perfection of Christianity*. The whole

whole of *Chriſtianity* is nothing but Rules for attaining this *Love*, or Meaſures whereby to remove the Impediments that hinder this *Principle of Reunion* (the ſource of *Charity*) from Operating, or means to deſtroy the contrary *Attractions* which diſturb the natural Operation of this *Principle of Reunion*; which wou'd of it ſelf, if not Stifled, Oppoſed, and Counteracted, neceſſarily beget this *Divine Charity*, whereby the Soul wou'd inſtantly be united with it's *Center*, and *ultimate End* the *ſupreme and abſolute Infinite*. q. e. d.

*Scholium.*

To this Doctrine of *pure Love*, there are made but Two Objections which have any Weight or Force in them. The Firſt is, that the *Motives* for *Love and Obedience*, urged by *Moſes* and the *Prophets*, CHRIST and his *Apoſtles*, are founded on *Rewards and Puniſhments*, and that therefore without *Blaſphemy*, we are not to offer at, or pretend to, more high and ſublime *Motives* or Principles, than the *Friend of* GOD, and the SON OF GOD, (the Standard in their ſeveral Diſpenſations, of Purity and Perfection) thought fit to preſs or propoſe. The plain and genuine Anſwer to this Objection is, that the *Author of our Being, who loves all his Creatures better*

*than they can love themselves*, uses all *Motives* that are *Honest*, *Laudable*, and *Just*, to gain them; he knows perfectly the *Frame* and *original Complexion* of all his Creatures, and that in their *lapsed State* they must ascend to Perfection by Steps and Degrees; and consequently that some are to be wrought upon by one *Motive*, others by another, and that generally the first Steps are mounted by the force *of the Terrors of the Lord*, before *the Love of* GOD *is shed in their Hearts*. There are *Babes in* CHRIST, as well as *grown and perfect Men*, and their Food (or Motives to Charity) must be as their Years and Strength are: But our SAVIOUR *tells us, we must love the* LORD *our* GOD *with all our Heart, with all our Soul, with all our Strength, and with all our Mind*, and if so, we shall have very little *Love* left behind, for *our selves*. And *his beloved Disciple* tells us, *that perfect Love casteth out Fear*, and consequently *Hope*, that is, *Rewards and Punishments*: Which are true, good, and *salutary* Motives, tho' not the best. The second Objection is from the impossibility of *Loving* or begetting *Love* without a Regard to *Rewards or Punishments*. But this Objection, arises from Ignorance of the true Nature of this Affection of the Soul. *Love* is the Complexion of the *Will or Desires*, as was shown *Prop.* 15. it belongs to the

*unin-*

*uninlighten'd Faculty* of the Mind, the *Will*, and not to the enlighten'd Faculty, as the *Underſtanding* is, and ſo naturally, and of it ſelf has no real reſpect to *Rewards or Puniſhments*, which are Motives offer'd by the Underſtanding; we *Love* becauſe we will *Love*, without *Reaſoning*, or becauſe the Object of our *Love* is amiable, and not becauſe it will hurt or heal us. *Love* is Blind, and belongs intirely to the *Will*, and not to the *Intellect*. But paſſing this, as perhaps too *Metaphyſical*, I anſwer, *Secondly*, as we may for one ſingle *Inſtant*, and for one ſingle *Act*, abſtract from a Reward, forget it, or counteract it, (which no Body who knows the preſcindent Faculties of the Soul, and that *Love* and Rewards are eſſentially united in their own Natures, can deny) ſo we may thus *Abſtract* again, and again, and ſo *in Infinitum* and thus beget a *Habit* for what may once be done, may for any impoſſibility in the Nature of the thing, be done *for ever*: This is *Demonſtration*. But I proceed,

*Propoſition* XXI.

In all intelligent Beings, there muſt be *Faculties* fitted for all the ſeveral *Ranks* of Objects, in the *Univerſitas rerum*; that is, ſince there are evidently Three *Ranks* of

Objects, in the *Universitas rerum*; to wit, the *material System* of Things, the *spiritual World* of created Spirits, and the *supreme and absolute Infinite.* Intelligent Beings must necessarily be fitted, with *Faculties* suited to these Three generical Ranks of Objects.

*Demonstrat.* This is evident from the several different *Mediums*, which all infer the same Conclusion. 1. Intelligent Beings are *Images* of the *supreme Infinite*, who alone perfectly comprehends and knows himself and all his Creatures, that is, all these Three *generical Objects*, in the *Universitas rerum.* He has different Sensations and Perceptions (as far as *Diversity* can be consistent with his infinite *Simplicity*) arising in himself from all these Three different Objects, and consequently Faculties fitted for them: Therefore intelligent Creatures, his *Images* the *Representations* of all his communicable Perfections, must of necessity, have *Analogous* Faculties, fitted for all these Three different Objects. 2. There are *Relations*, incumbent upon all intelligent Beings, towards each other, and towards the *supreme Infinite.* Such as *Love*, and *Benevolence*, therefore intelligent Beings must be endow'd with Faculties fitted for receiving the Impressions, and to perceive the effects of these *Relations*, else they wou'd be in vain: And these are Two of the different *Ranks* of Objects;

Objects; and no body questions intelligent Beings, being fitted with Faculties for the Third; to wit, the *material System* of Things. 3. As to the *spiritual World*, including the *supreme* and *absolute Infinite*, as it's *Head*. The *Principle of Reunion*, whose necessity in intelligent Beings, I have now Demonstrated, makes it absolutely necessary, they shou'd be provided with *Faculties* fit for *Communication* and *Union* with the *supreme Infinite*; else, they were not susceptible of that Happiness which was the *sole End* of their Being. 4. That which is the *Apodeictick Demonstration*, of the Truth of this *Proposition*, and at the same time proves the Diversity of these several Faculties, to be as real as that of the Objects is, is the manner after which compounded intelligent Beings, are provided with *Faculties* for the *material System* of Things. Material Things are presented to them only through their Senses; they have a real and material *influx* on these; else they are not really perceiv'd; and all real Knowledge of material Things, is convey'd into the Understanding, through these *Senses*. Wherefore it is evident, compounded intelligent Beings, are endowed with a Faculty of perceiving or receiving material Things, thro' their Senses, which is called *perception*. Next they have a Faculty of painting these Perceptions or

their Images when the Objects are absent, and this is called Imagination, and *lastly*, a Faculty of *Combining* and comparing the real Perceptions of these material Things or their *Images*, and this Faculty is called *Reason*. And all these *Three* distinct Operations belong to the *rational Soul*, in order to fit it for Communication with the material World. Now by the *Analogy* of Things, such like, and *similar* Faculties, must of necessity belong to the *spiritual* part of compounded intelligent Beings, to fit them for a communication with the Two remaining *Ranks* of Objects; to wit, a spiritual *Perception* and *spiritual Senses*, *Imagination* and *Understanding*, for the *spiritual* World of intelligent Beings, and *Divine Senses*, *Perception*, *Imagination* and *Understanding*, for communicating with the *supreme Infinite*. For this *Analogy* will perpetually hold good and true, from the *Simplicity* and *Unity* of the *Divine Nature*, to wit, such as the Faculties are by which we *communicate* with the *material* World, such *Analogically* and with proper Limitations, are those by which we *Communicate* with the *World* of Spirits, and the *supreme Infinite*. And as we see compounded intelligent Beings, have bodily *Senses* which solely belong to the *material* World, so in the *Analogy* of Things, they must have Faculties

different

different and distinct in themselves peculiarly fitted and appropriated to the other Objects in the *Universitas rerum.* Wherefore, *&c.* q. e. d.

*Corollary* I.

Hence, we may conceive the Reason why in *Holy Writ*, the whole Man is distinguished into *Body*, *Soul*, and *Spirit*; whence comes the distinction, of the *natural*, and *spiritual* or *inward Man*: Between the *Law of the Members*, and the *Law of the* Mind. These Distinctions, and Divisions, I say, are easily conceiv'd from the foregoing *Proposition.* For the Body and rational Soul belong to this *material System* of Things, and are fitted with Faculties for *Communicating* with it, and is called the outward Man, and the following it's practical Dictates in Rebellion against, and in Opposition to, the Dictates of the *Spirit*, the *inward* Man, the essential *Principle of Reunion*, the *Law of the* Mind, which is fitted only for *Communicating* with the *supreme Infinite*: I say, the following the practical Dictates of the first, in opposition to the *Dictates* of the latter, is called in the Language of the *Spirit*, the following the *Law of the* Members.

*Corol-*

*Corollary* II.

As there are *Three* different Principles, Orders, or *Predicaments* of Being; to wit, GOD the *Creator of all Things*, *created Spirits*, and *material Bodies:* So there are *Analogically* in compounded intelligent Beings, *Three* different and distinct Principles, adapted and appropriated, for Communicating with, and enjoying these respective Objects: Whereof every one is endowed with proper *Senses*, *Powers*, and *Faculties*, different and distinct from each other. That is, as the *material System* of Things, is the proper Object of the Senses, and rational Soul; and as this Principle is fitted with outward *Senses*, *Perception*, *Imagination*, *Understanding*, and *Will*; So the Principle, whereby they are fitted, to Communicate with the created spiritual World, is endowed with inward *Senses*, *Imagination*, *Understanding*, and *Will*; and the *supreme Spirit*, or Third Principle, whereby they are fitted to Communicate with the supreme uncreated Infinite, is endowed with *inmost* (so to speak) *Senses*, *Imagination*, *Understanding*, and *Will*; and all these in their *primitive* and *original* Constitution, in Subordination, *Harmony*, and Agreement, without Contrariety or Confusion one with another.

another. This *Corollary* is as certain as the *Analogy* of Things is.

*Corollary* III.

Hence, we may deduce the true and genuine Nature, and Extent, of the *Degeneracy*, *Corruption*, and *Fall*, of the Humane Race of intelligent Creatures; which conſiſts, in the *Confuſion*, *Diſcord*, *Rebellion*, and *Contrariety*, of theſe different and diſtinct Principles one with, and againſt another; in throwing of that *due Subordination*, *Subjection*, and proper *Rank*, and Order, that was originally eſtabliſhed among theſe Faculties; according to the Dignity of theſe different Objects; the Order of Nature, and the *Analogy* of Things, and following the practical *Dictates*, and Concluſions deduced from theſe rebellious Faculties. That is, when in this *Anarchical* and rebellious State, of humane Nature. The Faculties belonging to the material World, preſumes to Judge of, and determine the Nature of the Subjects, belonging to the *ſupreme* Spirit; takes the Government and Adminiſtration of the whole Man, which properly belongs, in the Order of Nature, to this Third Principle, leads the other Principles, as *Slaves* and *Captives*, and forces them to comply with the practical *Dictates* they preſcribe,

and

and deduce in their uſurp'd Superiority; and under this complyance, begetting and producing phyſical and durable Effects, the whole Order of Nature, and the material *Syſtem* of Things, ſo far as theſe *phyſical* and durable Effects reach, becomes Diſtorted, Inverted, and Corrupted.

## *Propoſition* XXII.

The *rational Soul*, is not that Faculty in compounded intelligent Beings, which in the Order of Nature, and the *Analogy* of Things, is appropriated for the ſpiritual World (including the ſupreme Infinite as it's Head.)

*Demonſtrat.* Tho' this be a neceſſary *Corollary* from the preceeding *Propoſition*, yet ſince it is of great conſequence to true Divine Knowledge, to have it's Truth eſtabliſhed beyond all poſſibility of *Cavil.* I ſhall here ſuggeſt ſome other *Mediums*, or ſet thoſe already ſuggeſted in another Limit, from whence the ſame *Concluſion* may be deduced. And 1. this is evident from the Nature of this *Faculty*, and the manner of it's Operating. *Reaſoning* is the comparing, or the conſidering the *Congruity* or *Incongruity* of the Perceptions, ſuggeſted by the Senſes, or of the *Ideas* lodged in the Memory, or Painted on the Imagination, to one another; and *Reaſon* is the Faculty whereby

whereby this is perform'd. Now the *Senſes* ſend in only, the *Influxes* of material Things, and the *Imagination* and *Memory* preſent only their Pictures or *Images*, when the Objects themſelves are abſent; and here is all the *rational Soul* can do. But nothing of theſe belong to the *ſupreme* and *increated Infinite*, nor the *ſpiritual World*. 2. It is acknowledged by all, and every one's Experience demonſtrates it to Him, that the *rational Soul* is fitted for *Communicating* with the *material World*. Now ſince Body and Spirit are preciſe and proper Oppoſites, it wou'd be as *Diſſonant* and *Incongruous*, in the *Analogy* of Things, that the ſame Faculty ſhou'd be the Principle of Communication with theſe two Objects, ſo widely diſtant, as that the *Eye* ſhou'd both *Hear* and *See*. It is true it may be ſaid, that the *rational Soul* might have been originally endowed with ſuch *Energy* and Capacity, as to be fitted for *Communicating* with *both Worlds*; but this is meerly *gratis Dictum*, and perfectly contrary to the *Analogy* of Things. It being impoſſible, to bring an Inſtance of Nature, where things ſo widely diſtant, and preciſely oppoſite are receiv'd by *one and the ſame* Faculty; we ſee in the *Body*, or loweſt part of the humane Compoſition that it is inſtructed, with *Organs* fitted for all the poſſible ways, ma-

terial

terial Things can act upon it. And they are not near so widely distant and different in their manner of Operating, as Bodies and Spirits in their Natures are. 3. There is a Two-fold Knowledge of material Things, one *Real*, when the thing it self, and the *real* Action and Impression thereof, on our Senses is perceiv'd. The other *Ideal*, when the *Image* or *Idea* of a thing absent in it self, is represented to, and considered on the *Imagination*. For Instance, the *Heat*, *Light*, and *cheerful Influences*, of the *Sun*, shining on us, are widely different, from the view and consideration of it's *Image*, or *Idea*, on our Fancy. In the *Analogy* of Things, and according to the constant Order of *Nature*, such must our Knowledge of *spiritual* Objects be, to wit, the one *real*, when the Objects make a real Impression upon the *appropriated* Faculty; the other *Ideal*, when we frame a Notion, of it's absent Substance and Qualities. Now it is very plain, the *rational Soul*, is not fitted for this first kind of Knowledge or Perception, of *spiritual* Objects; since a great many *Philosophical* and *Learned* Men, who have exercised this Faculty in it's greatest Strength and *Vigor*, have deny'd the Existence of such Objects. 4. Lastly, That most certain and self evident *Metaphysical Axiom*, to wit, *that nothing can be in the Understanding, that*

*was*

*was not first in the Senses*; is a certain *Demonstration*, that the *rational Soul*, is not the Faculty in intelligent Beings, *appropriated* to the *spiritual* World; for every Body allows, that *spiritual* Beings, *as such*, can never be convey'd, through the bodily Senses, to the Understanding. And therefore we must either be intirely depriv'd of Faculties, for communicating with *spiritual* Beings, (that is we must be depriv'd, of the only means of our *supreme Felicity*, and for attaining the end, for which alone we were created, to wit, communicating with the *supreme and absolute infinite Spirit.*) Or else, we must be endow'd with Faculties distinct from the *rational Soul*, for that purpose. Upon all which Accounts it is evident beyond the most remote possibility of Doubt, that the *rational Soul* is not that Faculty in compounded intelligent Beings, which in the Order of Nature, and the *Analogy of Things*, is *appropriated* for the *spiritual* World: But that they are endow'd with a *rational Soul*, and bodily Sense, to communicate with the *material* World, and with a *Spirit* and *Divine Senses*, to communicate with the *supreme Infinite*. So that the mentioned *Metaphysical Axiom*, continues just and true, as it shou'd according to the *Analogy of Things*: That as *material* things, are convey'd to the *rational Soul*, through the *bodily Senses*, so

*spiritual*

*ſpiritual* Things (thoſe that relate to *ſupreme Infinite*) are convey'd through the *Divine Senſes*, to the *Spirit*. q. e. d.

*Corollary* I.

Hence, in the *Analogy of Things*, as the *Light* of the *Sun* (that Noble and Glorious *Repreſentation*, *Image*, and *Vicegerent* of the *ſupreme Infinite*, in the *material* World) is the *Medium*, through which *material* Things are ſeen and perceiv'd in our *Syſtem*, ſo the *eſſential Light* of the *ſupreme Infinite* himſelf, is the ſole *Medium*, by and through which, his Nature and infinite Perfections are to be underſtood, and comprehended. And therefore as certainly, as the *Sun* ſends forth his Light on the whole *material* World without Bounds or Limits, on *the Juſt and on the Unjuſt*; ſo certainly, the *Sun of Righteouſneſs*, the *Pattern* and *Architype* of our *material Sun*, ſends forth his enlightning and enlivening Beams on all the *Syſtem* of created intelligent Beings, and is, *that Light which enlightens every Man that cometh into the World.*

*Corollary* II.

Hence it is evident, that he who wou'd Judge, Determine, and Purſue the practical Con-

Concluſions of theſe Determinations, about the Nature and Properties of *Spiritual* and *Divine Things*, by his *Reaſon*, wou'd act as incongruouſly, and contrary to the *Analogy of Nature*, as he who wou'd taſte Colours (as ſuch) and look into Sounds. The higheſt that this *Faculty* can juſtly and congruouſly pretend to in theſe Matters, is from the known, certain, and experienced Nature, and Properties of *material* Things, (to which the *rational Faculty* is in ſome meaſure adequate) by a proper *Analogy*: And from the *Viſible's* being low *Images* of the *Inviſible*, and *Spiritual*; to frame *Similar*, but imperfect *Likeneſſes*, and Repreſentations, of theſe ſuperior Objects; their Natures, and Properties, as we have endeavoured to do, in the preceeding *Propoſitions*, and this really, and in fact is all that *Reaſon* can do in theſe ſublime Matters.

*Corollary* III.

Hence, we may diſcover the Errors and Impieties of *Spinoſa*, and *Hobbes*; and the Miſtakes of a *latter Philoſopher*, I mean (the otherwiſe *Ingenious*) Mr. *Lock*. The *firſt* of theſe, conſidered this *univerſal Syſtem of Things*, as a kind of a *Huge-brute-animal*, actuated by a fatal, neceſſary, unintelligent, undeſigning Principle; without either Wiſ-

dom or Choice. The *Second*, considered *humane Nature* (not as it really is in it's present state of *Probation* and *Purification* a Mixture of moral and natural Good and Evil, but) in it's *Diabolical* and *reprobrated* Estate: Not as Groaning under it's present State of Corruption, and waiting and panting *for the glorious Liberty of the Sons and Children of God*; but as it will be in an habitual confirm'd Estate, of the *Anarchy* and Rebellion of it's Faculties one against another. In a Word, he considered *humane Nature* only, as it is in the worst of Men; or as it is supposed to be at last in a State of *final Impenitence*, and harden'd Impiety; and this he took as his *Original* to copy after, and his *Model*, whereupon he was to frame his *humane Creature*: And it must be allowed he has wrought it up to *the Life*. The *Third* considered Man, and his *Faculties*, not indeed in their already *reprobated* and *Hellish Estate*, but as he really now is, in the World, a composition of moral and natural Good and Evil: And this State he has very fairly and justly represented so far as it goes. But then, either having no Notion, or at least no Regard, to his *higher Faculties* (which in natural and lapsed Man, ly Buried under the Rubbish of his present Corruptions and Sensuality;) nor to his *regenerated*, *redintegrated* and *restablished Estate*, (to which he

he muſt be reſtored before he can reach the *End* of his *Being*.) No not ſo much as to conſider Man, as he really is, a *fall'n*, *depraved*, *vitiated* Creature, (in which State his *lower*, his *rational* Faculties are impaired; his *higher* Faculties, in ſome meaſure *obliterated*, at leaſt Buried and Oppreſſed by the load of preſent Corruption and Senſuality: And all of them in a State of *Anarchy*, Rebellion, and Contrariety one to another.) I ſay, from having no regard to thoſe *other* different, *real* Eſtates of *humane Nature*, his Accounts of it's Faculties, are *Lame* and *Imperfect*. His *Principles* when apply'd (by himſelf or his Diſciples) to Subjects (to which Faculties are appropriated, higher than thoſe he *elicits* out of the meer lapſed State of humane Nature) of a more elevated Order (ſuch as *Chriſtianity* and it's *Holy Myſteries*, *Faith*, *Grace*, *Divine Revelation*, and *Inſpiration*, and the Means of Man's Recovery) debaſe theſe into *meer Heatheniſh Morals*, or *Humane Philoſophy*, and ſink the *Oeconomy* of *the whole Wiſdom of the Godhead*, even below the poor Contrivances and barren Speculations of many of the *Gentile Sophiſts*. But thoſe who fully underſtand the *Principles*, and are convinced of the *Truth* of the *Propoſitions*, I have laid down, will eaſily perceive the ground of the Errors and Miſtakes of theſe Three

*Setts* of *Philoſophers*: And be able to anſwer their Arguments without my being obliged to detail them.

## *Propoſition* XXIII.

In the *Analogy of Things*, and Order of Nature, as the *material World*, is to *Univerſal Space*, it's higheſt Limit and Boundary, ſo is the *Spiritual World* to the *ſupreme and abſolute Infinite*, the higheſt Limit and Boundary of all Things.

*Demonſtrat.* This is evident from *Lemma* 1. with *Prop.* 9. and 17. There is a Beautiful *Analogy*, and Uniformity running thro' the whole *Syſtem* of Creatures. The *Viſible* and the *Created*, are *Images* of the *Inviſible* and of the *Increated*. The *Syſtem* of intelligent Beings are more exalted, more noble, and more immediate *Images* of the *ſupreme Infinite*. The *Analogy of Things* runs quite through the whole *Syſtem* of Creatures, up to their original Pattern and *Architype* in the Divine Nature, in a continued Subordination and Scale; according to their reſpective Natures. The *material* World is an *Image* of the *ſpiritual* World, as the *ſpiritual* World is of the *ſupreme Infinite*. As *Infinite Space* is the *Locus* and Boundary of the *material* World, ſo is the *ſupreme Infinite*, the *Analogical Locus* (in whom

whom *they all Live, Move, and have their Being*) and the *Omega* of all Things, *Spiritual* and *Material.* And as *Space* is *Similar* to a *ſpiritual* Subſtance, ſo is that to the *Divine Subſtance*, therefore, *&c.* q. e. d.

*Corollary* I.

Hence *material* and *ſpiritual* Subſtances, are both of them *extended*; for ſince the *material* World, is to *univerſal Space*, as the *ſpiritual* World, is to the *ſupreme Infinite*; and ſince both *Matter* and *Space* are extended, ſo alſo muſt ſpiritual Subſtances be: And the *Divine Ubiquity*, and *Omnipreſence*, not *Virtually* only, but *Subſtantially* and *Eſſentially*; makes it not unlikely that there may be, in the *Divine Subſtance*, a reſemblance of *Extenſion* (ſo far as a reſemblance and ſimilitude of Subſtances can reach, between a *relative Infinite*, ſuch as *univerſal Space* is, and the *ſupreme Infinite*) but infinitely more pure and perfect, than that of created *Space* is, or can be.

*Corollary* II.

Hence *Matter* and *Spirit* are Oppoſits in every other Quality, except in that of *Extenſion*; for ſince by *Converſion of Ratio's*, the *material* World, is to the *ſpiritual* World, as

*infinite Space* is to the *supreme Infinite*; and and since these two last, to wit, *universal Space*, and the *supreme Infinite*, are opposits in every other Quality, but in a resemblance of Substances, and that too, at an *absolutely Infinite* Distance, as is evident at first view; therefore the *other Two* must be opposite, in every other Quality but *Extension*, for tho' *extended Matter* be divisible by being *Extended*; yet *Space* is not actually to be divided; or one part of it separated from another. Since it is the *universal Locus* of, and penetrates all Bodies: And it is in *this* Sense, that the opposition of these two Qualities in *Body* and *Spirit*, is meant here.

## *Proposition* XXIV.

By the *Analogy of Things*, and according to the Order of Nature, a *Spirit* is an *extended*, *penetrable*, *active*, *indivisible*, *intelligent* Substance.

*Demonstrat.* By *Def.* 2. *Matter* is an *extended*, *impenetrable*, *passive*, *unintelligent*, *divisible* Substance: And since by the *preceding Corollary*, *Matter* and *Spirit* are in every other Quality opposite, except in that of *Extension*; therefore in place of all the qualities in the *Definition of Matter*; putting their Opposits, excepting in that of

*extended*

*extended* Subſtance, (for *Extenſion* muſt imply a Subject) and then a *Spirit* will become, according to the *Propoſition*, an *extended*, *penetrable*, *active*, *indiviſible*, *intelligent* Subſtance. I have choſen the Word *Intelligent*, in this, and it's oppoſite *Unintelligent*, in the other Definition. To wit, in that of *Body*, rather than that of *Thinking*, becauſe *Intelligence* is the Source and Principle of *Thinking*, and expreſſes the *whole* of all the Faculties of *ſpiritual* Subſtances.

*Corollary* I.

Hence, in reſpect to their Subſtances only, a *material* Subſtance is an infinitely condenſed, or incraſſated, *ſpiritual* Subſtance: And on the other Hand, a *ſpiritual* Subſtance, is an infinitely rarify'd, or refin'd material Subſtance. As we have it in Holy Writ, there is a *natural* (or material) *Body*, and *there is a ſpiritual*, and *a glorified Body*. For ſince *Matter* and *Spirit*, have the Foundation of their Qualities common to both, to wit, an *extended* Subſtance: Since all their other Qualities are the one, reſpectively the Oppoſite or Negative of the other. Since *rarifying* any Quality in *Body* and *Spirit*, is ſubtracting from it's Intenſion and Energy, and therefore an infi-

nite Rarefaction of a Quality, is subtracting it intirely; and there being no *mean* between *Penetrability* and *Impenetrability*, between *Passivity* and *Activity*, *Divisibility* and *Indivisibility*, *Intelligence* and *Unintelligence*, they being contrary and Opposite; therefore, the infinite Rarefaction of the one Quality, is the Position of it's contrary; for tho' the finite *Subtraction* of a *negative* Quality (admitting no *mean*) puts nothing, yet the infinite *Subtraction* of such a *negative* Quality puts the *Affirmative* (thus $-02 \times -\Theta = +0$. but $-\infty\, 0 \times -\Theta = +\Theta$) therefore in *Matter*, *subtracting infinitely*, all it's *positive* Qualities, or which is the same, (by the *preceding Corollary*) in *Matter*, *Subtracting infinitely*, the *negative* Qualities of *Spirit*, and then a *material* Substance will become a *spiritual* Substance; but since an infinite Rarefaction, of a contrary Quality, is the same with an *infinite Subtraction* of that contrary Quality, and since the same manner of Reasoning holds good in an *infinite Condensation*, of the Qualities in *Spirit*. Therefore in respect of their *Substances* only a *material* Substance, *&c.* q. e. d. The Case in short, as I conceive it, is thus. A *spiritual* Substance, when infinitely condensed and *incrassated*, looses it's Qualities of *Penetrability*, *Activity*, *Indivisibility*, and *Intelligence*. These being lock'd up, and as

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it were *crampt*, in this *Condenſation* of their *Subſtratum* (or the Subſtance in which they eſſentially inher'd,) thus *infinitely Compreſs'd*. The *Actuality* (as the *Metaphiſicians* ſpeak) of theſe *ſpiritual* Qualities being thus ſhut up and impriſon'd, tho' their *Potentiality* be not quite deſtroyed, and thus a *craſs*, *extended*, *impenetrable*, *paſſive*, *diviſible*, *unintelligent* Subſtance is Generated, which we call *Matter*, but when this *Matter* thus form'd of a *ſpiritual* Subſtance, is again *infinitely* refin'd, and exalted, theſe *Powers*, and *Qualities* are unlooſed, ſet at freedom again, and exert themſelves as formerly, and thus become what they were originally made. But we muſt take care not to imagine that any *finite Subtilſation*, *Diviſion*, *Refinement*, or *Exaltation* of groſs *Brute-matter*, can in any the leaſt degree, by any finite created Powers whatſoever, bring it to any but an infinitely diſtant Approach to this ſtate of *Spirituality*; ſince it has been demonſtrated, *in the firſt Chapter of this Part*, that no Finite how great ſoever, can be any finite Part, of any *relative Infinite* how ſmall ſoever: No Power, leſs than his, *who out of the very Stones cou'd raiſe* (by Virtue of their original *Potentiality*) *Children to Abraham*, can out of *material*, bring *ſpiritual* Subſtances, or on the contrary, convert theſe into thoſe.

*Corol-*

*Corollary* II.

Since in ascending from *material* Substances, there can be no such thing, by the *Analogy* of Things and Order of Nature, as a *Jump* or *Leap*, from one extreme to another, without passing through the intermediate Steps; and since in *material* Things, there are Substances of all degrees of *Density*, and *Rarity*. *Earths* more Dense than *Water*, *Water* than *Air*, *Air* than *Ether*, *Ether* than *Light*. So in the *spiritual* World, there must be *Spirits* of all degrees of *Rarity*, the one *Sett* and Rank, more pure, and refin'd, than the other, in a perpetual *Scale*, 'till they ascend so near the *supreme Infinite*, as Creatures can approach their *Creator*, or *Finites* the *absolute Infinite*. And by the same *Analogy of Things*, as in the *material* World, these several Orders of Bodies, *Earth*, *Water*, *Air*, *Ether*, and *Light*, have their proper *Places*, *Elements*, and *Centers*, where they rest, and whether they tend, and out of which they cannot be detain'd but by *Violence*; so in the *spiritual* World, there are *Centers*, *Spheres*, and *Elements*, of several Orders of *Spirits*, the one more pure, and refin'd than the other, (the more pure still penetrating the less pure,) where they rest, and continue, to which

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by their *ſpecifick* Degree of Purity, they are confin'd, out of which they cannot be detain'd but by *Violence*; all in a Subordination one to another, depending on their particular degrees of Purity, penetrating one another without Confuſion or Contrariety, 'till they arrive as near as is poſſible to the *ſupreme Infinite*, who penetrates the whole *Syſtem* of Creatures.

*Corollary* III.

Since by *Prop.* 15. the *Deſires*, are the *Cardinal* Faculty of intelligent Beings, infinitely *Active*, and Powerful, belonging to that Principle in them, which is appropriated to the *ſpiritual* World. By theſe *Deſires* therefore, thoſe of the ſame *Element*, and ſame Degree of Purity, are enabled to communicate one with another: But ſince the more pure penetrate the leſs pure, but not *vice verſa* (as is plain from *Corollary* 1. of the *preceding Propoſition*,) the more pure may penetrate the leſs pure, contrary to their *Deſires*; but not *vice verſa*, this Superiority of the more pure, over the leſs pure, being a neceſſary conſequence of the greater degree of Purity and Perfection. For as in the *material* World, the *Sun* purifies and rarifies Terreſtrial Bodies, the nearer they approach, or are brought to him: And at

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last converts them into his Substance. So in the *spiritual* World, the *Sun's* Pattern, and *Architype*, the *Sun of Righteousness*, renders those *Spirits* the more pure penetrating (and as it were *Deifies* their intimate Substances) whose *Elements* or Region is nearest him. By which, they more nearly partake of his Nature who penetrates the whole *System* of Beings.

### *Corollary* IV.

Hence, since the *supreme Spirit*, in compounded intelligent Beings is more pure (as being the highest Principle; and that *Breath of Life*, which they had immediately from the Divine Substance) than the *rational Soul*, the *first* penetrates the *latter*, and the *latter* is but the *Medium*, and is it self but of an intermediate Nature, between the two *Extremes*, *Body* and *Spirit*, coupling them togther by it's intermediate Substance. And in their primitive Order and Institution, they were in a due Subordination, one to another. The *Body* to the *rational Soul*, and *both* to the *supreme Spirit:* And in this Subordination, preserved and maintain'd, and diligently cultivated, according to their respective Dignity; in the *Will's* obeying, and approving of; and in the *whole Compound's* pursuing the practical Inferences deduced

duced in this *State*, did the *original Rectitude* of theſe compounded intelligent Beings conſiſt. And in the Contrariety, Contradiction, and Rebellion, of theſe different *Principles*, one againſt another, in the *Will's* obeying, and approving of, and the *whole Compound's* purſuing, the practical Concluſion's deduced under this State of *Anarchy*, does the *Fall*, *Lapſe*, and *Degeneracy* of this *Sett* of intelligent Beings conſiſt. And for the reſtoring, rectifying and re-eſtabliſhing the primitive Order and State, of theſe three Principles, to a habitual and laſting Subordination, was the Incarnation of the *Divine* LOGOS, and whole *Oeconomy* of the Redemption of Man.

*Corollary* V.

Hence, the *ſupreme Spirit*, may be Dark, Dead, and almoſt quite Obliterated, as to it's *ouvert* Acts (the *Principle* it ſelf, being eſſential to, and interwoven with, the moſt intimate Natures of all intelligent Beings,) when the *rational Soul* is full of *Ideas*, Pictures, and Images of Things. And on the other hand the *ſupreme Spirit* may be full of *Light*, *Brightneſs*, *ſubſtantial Knowledge*, *Joy* and *Peace*. When the *rational Soul*, is but Weak, Faint, and Languid, and almoſt void of all *Ideas* and Images; theſe being

being not only separable, but at last to be *actually* separated. (So far at least as the acts of the *rational Soul*, can affect the *supreme Spirit*,) when the LOGOS (that *eternal and essential Word of God*) *which is quick and powerful, and sharper than a Two-edged Sword, shall pierce, to the dividing asunder the Soul and Spirit.*

## *SCHOLIUM GENERALE.*

Thus I have endeavoured to give some faint, and imperfect Images, of the highest and most sublime Speculations of *Religion* and it's *Philosophy*, in the *preceding Propositions* and *Corollaries*. And tho' I am very far from thinking, they are even just, and compleat Images, and such as might be drawn from the same Principles, by a more skilful Hand. Yet I am fully convinced, the *Propositions* and *Corollaries* themselves, are true and just, as to their Substance; whatever may be in my way of explaining or demonstrating them; so far at least, as *Reason* can find out the *Truth* in such *sublime Mysteries*. I am also well satisfied, that *Reason* can with any propriety or justness, apply it self to Objects to which it is not *adequate* and appropriated, after no other manner, but by supposing those Objects, to which it is *adequate*, *Images*

*ges* or Repreſentations, of thoſe other Objects, to which it is not adequate. There being no other poſſible way for *Reaſon* to find a *Medium* of it's Knowledge, of Objects that are convey'd to the rational Underſtanding, by none of the bodily Senſes. (as the proper Objects of it's Faculties are.) And there being an abſolute neceſſity, from the *ſimplicity* and *uniformity* of the *Divine Nature*, and of his manner of Operating, that all his Works ſhou'd be Reſemblances and *Images* one of another, (more or leſs perfect, according to their reſpective Natures,) and alſo of himſelf, their *original Pattern* and *Architype*. This manner of Reaſoning, and this *Medium* of rational Knowledge, duly inſtituted, muſt be juſt and true, as far as it reaches. And thus far *Reaſon* can go, and not one ſtep further, in the Knowledge of ſuperior Objects; it can frame and form *Images* of theſe ſuperior Objects, from what it finds and certainly knows of the *material* World, to which it is in ſome meaſure adequate. *Images* I ſay, not *Metaphorical* only, but *Real* and *Phyſical*, as a Statue repreſents a Man, a Picture in *Miniature*, one from the Life, as a *Seed* (which is really the plant it ſelf in little) does a grown plant, or an *Embryo*, the adult Animal: This is the Boundary of *Reaſon* in theſe ſuperior Objects. And it is very obſer-

observable, that there are various Images in Nature, and in the *intellectual Species* of Things (fram'd upon what the Senses have already convey'd into the rational Understanding) of all the most unconceivable, the most abstruse, and sublime *Mysteries* of Religion and it's Philosophy; each superior to another. Can there be a more perfect, noble, or lively Image in this lower World, of the *Divine Nature*, *Light*, *Benignity*, *Greatness*, and *Power* required, than that of the *Sun*, in respect of our *Planetary System*. His Beams shine, and are transmitted through all the *Planetary* and *Cometary* Regions, even into the *Systems* of the *fix'd Stars*. He *attracts* all the *Planets* and *Comets* in our *System*, and is the Source of all their regular, uniform, and constant Motions and Influences. He warms, cheers, enlivens, and fertilises all the *Elements*, *Vegetables*, and *Animals*; and is indeed the *material Deity* of this inferior World. Is there not a plain and obvious Image of the EVER-BLESSED-TRINITY IN UNITY, in every Order of Creatures? In the three Dimensions of Bodies? In Nature's never rising above the *Third* Dimension in her regular Operations as was shown in *Scholium Prop.* 12? In the *Three* infinite Powers of *universal Space*? In the *Three* generical Divisions of Objects? *Matter*, *created Spirit*,

*Spirit*, and the *Supreme Infinite* in the *three* Distinctions and *Universal Principles* that comprehend the whole of material Intelligent Beings? The *Faculty*, *Object*, and the *Congruity* or *Incongruity* between these? The *Profane* and Ignorant may make a Jest of this *Ternary* Chain, and ascribe it to Chance or Fortune. But the *Analogy of things*, and the regular Uniformity in Nature, make it evident to a *Demonstration*; that it must have had its Rise in its *Original Pattern* and *Architype*, the *Divine Nature*. Even the Eternal *Generation* of the *Second* Principle in the *Godhead*, of the *First*, and the Eternal *Procession* of the *Third* Principle from the *First* and *Second*, comes evidently out of this *Analogical Ternary*, when elevated to its Origin in the Divine Nature; as was shewn in *Scholium* 2. *Prop.* 17. And the impossibility of increasing or multiplying the Divine and *Supreme Infinitude*, even by itself, so far as that it is uncapable of Increase, or Diminution; as was shewn in *Corollary* 2. *Prop.* 12. pictures forth, the *Unity* of the Divine Nature, in these *three* Relations of the *whole* to the *whole*. How noble a Representation in Created things, is the *Universal Space* of the *Divine Ubiquity*, *Infinitude*, and *Spiritual Nature*? how lively a Picture in the *Intellectual Species* of things, of *Creation*, or of Gods producing the things that be, out of the things that were not, is that *Proposition* Demonstrated *Corollary* 2. *Prop.* 2. $\frac{1}{1+1+1+1+1+1}$ &c. $\times 0 = \infty$ $\times 0 = 1$. or $\frac{\odot}{\odot+\odot+\odot+\odot+\odot}$ &c. $\times$

$o = \infty \odot \times o = \odot$? The production of a *Plant* from its *Miniature* in the Seed; and of an *Animal* from an *Animalcule*, is an astonishing Representation of the Resurrection of the Body. These and many such Resemblances, and Images in Nature, in the *Sensible* and *Visible* things, and in the *Intellectual Species* of things, derived through the Senses; might be brought to illustrate and confirm the greatest Difficulties and most abstruse Mysteries of *Religion*, and its *Philosophy*. So certain and universal is the *Beautiful Analogy of Things*, and so careful has the *Kind* and *Bountiful Author* of our Beings been, to supply us with Evidences in our *lower Faculties*, and *lapsed* Estate, of *those Truths* he requires us to believe and receive. The *full* and *compleat* Conception and Knowledge of which, belong not but to our *Superiour* Faculties, and to our *Restored* and *Re-established* Estate. May we then use the Assistances, *Reason*, and the *Divine Bounty*, has afforded us, (I may almost say, even beyond and out of their Natural Order) for increasing our *Faith*, Cultivating and expanding our *Superiour Faculties*, rescuing us out of our *Degeneracy* and Corruption, *into the Glorious Liberty of the Sons and Children of God*, and then, *in his Light we shall see Light*, Amen.

CHAP.

## CHAP. III.

*Of the USE of the Arithmetick of Infinites.*

§ I. IN Arithmetical Progreſſion; in which let $a$ denote the firſt, $v$ the laſt term, $x$ the Difference, $t$ the Number of Terms, and $z$ the Sum of all the Terms, which in an aſcending Progreſſion are $a$, $a+x$, $a+2x$, $a+3x$, &c. but in a deſcending Progreſſion $a$, $a-x$. $a-2x$, $a-3x$, &c.

Having any three of theſe five $a, v, x, t, z$. you may find the other two by help of theſe two Lemma's,

Lem. 1. $\left\{ v = a + tx - x \right\}$ but $v = a - tx + x$,

Lem. 2. $\left\{ 2z = t \times \overline{a + v} \right\}$ when it deſcends.

I ſhall here only treat of aſcending Progreſſions, judging thoſe that deſcend as not properly belonging to the Arithmetick of Infinites.

Now in aſcending Progreſſions both $t$ and $v$ are infinite.

Therefore *Corol* 1. $\left\{ v = tx \right\}$ in the Caſe of

And *Corol* 2. $\left\{ 2z = tv \right\}$ Infinites.

Becauſe Infinites are not all equal, but vary in their Ratio's to one another, as much as finite Quantities do; therefore to avoid confuſion, I ſuppoſe $v = \infty \times 1 = 1 + 1 + 1 + 1 + 1 + 1$ &c.

So from *Corol.* 1. $t = \frac{\infty}{x} = \infty \times \frac{1}{x} = \frac{1}{x}$

$+ \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x}$ &c.

*Prop.* 1. $z = \frac{\infty^2}{2x}$. This follows from substituting the Value of $t$, *viz.* $\frac{\infty}{x}$ in *Corol.* 2.

*Exemp.* 1. Let $x = 1$. then $1+2+3+4+5$ &c. $= z = \frac{\infty^2}{2}$, that is, the Sum of all the natural Numbers continued in *infinitum* is equal to half the Square of Infinite: and here it is to be noted, that in this Case only $t = v = \infty \times 1 = 1+1+1+1+1$ &c.

*Exemp.* 2. Let $x = \frac{1}{2}$, then $1+1\frac{1}{2}+2+2\frac{1}{2}+3+3\frac{1}{2}$ &c. $= z = \infty^2 =$ to the Square of Infinite.

And thus may you find the Ratio between the Sum of any ascending Arithmetical Progression, and the Square of Infinite; and Note that by Infinite, is always understood Infinite in General, or Infinite of the simplest Nature and Lowest Degree, $1+1+1+1$, &c. unless it be otherwise expressly declared.

*Corol.* $\infty \times \frac{1}{\sqrt{2x}}$ is the Root of a Square, which Square is equal to the Sum of any Arithmetical Progression ascending in *infinitum*. *Exemp.* Let $x = 2$, then $\infty \times \frac{1}{2}$ (or an infinite number of $\frac{1}{2}$) is the Root of a Square equal to the Sum of that Progression, *viz.* $1+3+5+7$ &c. $= \overline{\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}}$ &c.$|^2_4$

Corol.

*Corol.* 2. Let $a = \infty n$, $v = \infty m$. $t = \infty p$. Theſe values of $a$, $v$, $t$, being ſubſtituted in Lem. 2. will give you $2z = \infty p \times \infty n + \infty m = \infty^2 \times \overline{pn + pm}$, or $z = \frac{\infty^2 \times \overline{pm + pn}}{2}$, and the common Difference $x = \frac{m - n}{p}$, as you may eaſily find from *Lem.* 1.

You may expreſs the Sum $z$ otherwiſe, for $t = \frac{v - a}{x}$ by *Lem.* 1. Therefore $\frac{v - a}{x} \times \overline{v + a} = 2z$ by *Lemma* 2*d.* that is $z = \frac{v^2 - a^2}{2x} = \frac{\infty^2 m^2 - \infty^2 nn}{2x} = \frac{\infty^2 \times \overline{mm - nn}}{2x}$,

*Corol.* 3. From *Prop.* 1. and *Corol.* 2. it is evident that in two Arithmetical Progreſſions having the ſame common Difference $x$, the Sum of that whoſe terms are infinite, is to the Sum of that whoſe terms are finite, as $m^2 - n^2$ to 1. For the Sum of the firſt, by *Corol.* 2. is $\infty^2 \times \frac{m^2 - n^2}{2x}$, $x$ the Sum of the other, by *Prop.* 1: is $\infty^2 \times \frac{1}{2}x$.

*Corol.* 4. From hence may be ſolved this Problem. Any Arithmetical Progreſſion being given as $a, a + x, a + 2x, a + 3x$, *&c.* whoſe terms are finite; to find another conſiſting of Infinite

Terms, that shall have the same Difference $x$, and whose Sum shall be equal to the Sum of the given Progression. *Solution.* $m^2 - n^2 = 1$ from *Corol* 3. *& ex hypothesi.* Therefore $m^2 = 1 + n^2$; so to find $m$ and $n$, is an indetermin'd Problem, whose Solution by the known Methods will give you $m = \frac{e^2 + 1}{e^2 - 1}$, $n = \frac{2e}{e^2 - 1}$, where $e$ is any number ( $> 1$ ) taken at Pleasure. So then these Values of $m$ and $n$ being substituted in the Values of $a$ and $v$, of *Corol.* 2. will give you the first Term $a = \infty \times \frac{2e}{e^2 - 1}$, and the last $v = \infty \times \frac{e^2 + 1}{e^2 - 1}$, and calling the common Difference $x$, you will have a Progression, each of whose terms is infinite, and whose Sum shall be equal to the Sum of any other Arithmetical Progression, whose first term is finite, and the common Difference $x$; and because $e$ is an Arbitrary number, therefore you have as many of such Progressions as you please, to answer the *Problem.*

*Exemp.* Let the given Progression be $1 + 2 + 3 + 4 + 5$ *&c.* where $x = 1$, so the Sum thereof is $= \infty^2 \times \frac{1}{2}$ (as in *ex.* 1. *Prop.* 1) now taking $e = 2$, you will have $n = \frac{2e}{e^2 - 1} = \frac{4}{3}$ *&c.* $m = \frac{e^2 + 1}{e^2 - 1} = \frac{5}{3}$, which from the second expression of

of *Corol.* 2. will give the Sum of the ſeries $(\infty \times \frac{4}{3}, 1 + \infty \frac{4}{3}, 2 + \infty \frac{4}{3}, 3 + \infty \frac{4}{3}, \&c.)$ $\infty^2 \times \frac{m^2 - n^2}{2x} = \infty^2 \times \frac{\frac{25}{9} - \frac{16}{9}}{2x} = \infty^2 \times \frac{1}{2}$, which is the ſame with that of the given Progreſſion conſiſting of finite terms.

*Schol.* The Problem may be made more general, and the Solution as eaſy, if it were required, that the Sum of the Series conſiſting of infinite Terms, ſhould be to that of the other conſiſting of finite Terms in any given Ratio of $r^2$ to $s^2$, for then it muſt be to find $m$ and $n$, ſuch that $m^2 - n^2$, $1 :: r^2 : s^2$.

*Prop.* 2. Let all things be as in *Prop.* 1. except the laſt Term, which here we ſhall ſuppoſe $v = \infty n$, in which Caſe I ſay $\left\{ z = \infty^2 \times \frac{nn}{2x} \right\}$

*Exemp* 1. Let $n = 2$, $x = 1$; $a = 1$, ſo the Progreſſion will be 1, 2, 3, 4, 5, *&c.* till the laſt Term be $\infty$ 2, I ſay the Sum $1 + 2 + 3 + 4 + 5$, *&c.* $= z = \infty^2 \times 2 =$ double the Square of Infinite.

§. II. In Geometrical Progreſſion, let $a$ denote the firſt, and $v$ the laſt Term, the Ratio of the Terms, that of $r$ to $s$, $t$ the Number, and $z$ the Sum of all the Terms of any Geometrical Progreſſion, which will be $a, \frac{sa}{r}, \frac{s^2 a}{r^2}, \frac{s^3 a}{r^3}, \frac{s^4 a}{r^4}$.

Of theſe five things, *viz.* the firſt Term $a$, the laſt Term $v$, the Ratio of the Terms $\frac{r}{s}$, the

and the Sum of the Terms $z$, ha- three, you may find the other two by the two *Lemma's*.

*Lem.* 1. $v = \frac{\overline{s}^{t-1}}{\overline{r}^{t-1}} \times a$

*Lem.* 2. $sz + ra = rz + sv$

From *Lemma* 2*d.* it follows that $z = \frac{ra - sv}{r - s}$ when the Progression descends, that is, when $r < s$.

But when the Progression ascends, that is, when $r > s$ then from *Lemma* II. it will be $z = \frac{sv - ra}{s - r}$

Case 1. In descending Progressions where the number of Terms are infinite, the last Term $v$ will be $= 0$.

*Prop.* 1. In all descending Progressions, whose number of Terms are infinite, and first Term finite, the Sum of the Progression is a finite quantity *viz.* $z = \frac{ra}{r - s}$

*Corol.* 1. Let $a = r$, then $z = \frac{r^2}{r - s}$

*Exemp.* Let $r = 1$, $s = \frac{1}{2}$, then $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$ &c. $= 2 = \frac{r^2}{r - s} = z$

*Prob.* Having the first Term $a$, and the Ratio of the Terms $\frac{r}{s}$ of any Geometrical Progression

ſſion deſcending in *infinitum*, till $v = 0$, to find another Progreſſion deſcending in *infinitum*, whoſe firſt Term ſhall be any given number $b$, and its Sum equal to the Sum of the given Progreſſion.

*Sol.* Let $m$ to $n$ be the Ratio of the Terms of the Progreſſion ſought; now $\frac{ra}{r-s}$ is the Sum of the given Progreſſion, by *Prop.* 1. and for the ſame reaſon $\frac{mb}{m-n}$ muſt be the Sum of the Progreſſion ſought, therefore from the condition of the Problem ſought $\frac{mb}{m-n} = \frac{ra}{r-s}$, which gives $n = \frac{m \times ra - rb + sb}{ra}$, where $a, r, s, b$ are given, and $m$ may be taken at Pleaſure; and ſo you have $n$ from this Equation; and conſequently the Progreſſion ſought is found; for a Progreſſion is found, when you have the firſt Term $b$, and the Ratio of the Terms $m$ to $n$.

*Example.* Let $r = 1$, $s = \frac{1}{2}$, $a = 1$; $b = \frac{2}{3}$, I aſſume $m = \frac{1}{1}$ $(= b)$ ſo the Equation will give $n = \frac{4}{3}$, therefore $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8}$ *&c.* $= \frac{2}{3} + \frac{4}{3} + \frac{8}{27}$ *&c.*

And here it is to be noted that ſince $m$ is taken at Pleaſure, the Problem is indetermined, and ſo you may find as many Progreſſions as you pleaſe, whoſe Sum ſhall be equal to the Sum of any given Progreſſion.

*Schol.* The Problem will be more general, if

it

it be required that the Sum of the given Progression $\frac{ra}{r-s}$ be to the Sum of the Progression sought $\frac{mb}{m-n}$ in any given Ratio $h$ to $k$ *viz.* $\frac{ra}{r-s} : \frac{mb}{m-n} :: h : k$, which gives $z = \frac{m \times a\,rk + bhs - bhr}{akr}$; where $m$ is at Pleasure.

Case II. In ascending Progressions, whose number of Terms are Infinite, the last Term $v$ will be $= \infty \times e$; but first I shall consider these Progressions in which $e = 1$, that is, where the last Term is an infinite number of Units.

*Prop.* 2. $z = \infty \times \frac{s}{s-r}$ $(= \frac{sv}{s-r})$ for $ra$ vanishes, because $a$ is finite, and $v$ infinite.

But here it is carefully to be observed, that in all these Progressions it is necessary to make $a = r$, so that $r$ will be the first and $s$ the second Term of the Progression; and indeed in all Geometrical Progressions, there is a convenience of expressing the Ratio of the Terms by the two first Terms of the Progression.

This being premised, it is evident that $\frac{s}{s-r}$ is the infinitely small and equal part, of which an infinite number gives the Sum of any Geometrical Progression ascending in *infinitum*.

*Examp.*

*Examp.* 1. Let $r = 1$, $s = 3$, then $\frac{s}{s-r} = \frac{3}{2}$, which shews $z = \infty \times \frac{3}{2}$, that is $1 + 3 + 9 + 27 + 81$ &c. $= \frac{3}{2} + \frac{3}{2} + \frac{3}{2} + \frac{3}{2}$ &c.

*Examp.* 2. Let $r = 1$, $s = \frac{3}{4}$, so $\frac{s}{s-r} = 3$, Ergo $z = \infty \times 3$, that is, $1 + \frac{3}{4} + \frac{27}{8} + \frac{81}{16}$ &c. $= 3 + 3 + 3 + 3$ &c.

*Problem.* To find a Progression, which shall have any given number ($a$) for the equal part of which its Sum consists. *Solution.* Let $r$ be the first, and $s$ the second Term of the Progression sought, then (because $\frac{s}{s-r}$ is the equal part for every Progression) $\frac{s}{s-r} = a$ which gives $s = \frac{ra}{a-1}$, so taking the first Term $r$ at Pleasure, the second shall be $\frac{ra}{a-1}$.

*Examp.* To find a Progression whose Sum shall be $= \infty \times 2$. In this Case $a = 2$, so taking $r = 1$, it will give $\frac{ra}{a-1} = 2$ which shews that the Sum of a Progression, whose first Term is 1, and second Term is $2 = \infty 2$, or $1 + 2 + 4 + 8$ &c. $= 2 + 2 + 2 + 2$ &c.

*Scholium.*

*Scholium.* Becauſe $r$ is taken at Pleaſure, therefore you may find as many Progreſſions as you pleaſe, whoſe Sums ſhall be all equal, becauſe each of them is $= \infty \times a$.

*Prob.* 2. Having any Progreſſion aſcending, to find another whoſe Sum ſhall be equal to the Sum of the given one. Let $r$ be the firſt, $s$ the the ſecond Term of the given Progreſſion; and $m$ the firſt, $n$ the ſecond Term of the Progreſſion ſought, then $\infty \times \frac{s}{s-r}$ is the Sum of the given one, and $\infty \times \frac{m}{m-n}$ is the Sum of the Progreſſion ſought, *Ergo* $\infty \times \frac{s}{s-r} = \infty \times \frac{m}{m-n}$, or $\frac{s}{s-r} = \frac{m}{m-n}$ which gives $n = \frac{rm}{s}$, $m$ may be taken at Pleaſure, and ſo you have $n$.

*Schol.* So may you find a Progreſſion, whoſe Sum ſhall be to the Sum of the given one, in any given Ratio $h$ to $k$. for then $\frac{m}{m-n} : \frac{s}{s-r} :: h : k$: ſo that $n = \frac{m \times \overline{sh + rk - sk}}{sh}$

§ III. Before I proceed to other Progreſſions, it will be neceſſary to ſubjoin ſome things, which were omitted in § I. concerning Arithmetical Progreſſion, and which ſhould have immediately pre-

preceeded § 2.

*Lemma.* $z = \infty^2 \times \frac{1}{2x}$, when $v = \infty \times 1$. by *Prop.* 1. of § 1.

*Prob.* Having the common Difference $x$, and the laſt Term $v = \infty \times 1$ of any Arithmetical Progreſſion aſcending in *infinitum*; to find another Arithmetical Progreſſion, whoſe Sum ſhall be equal to the Sum of the given one.

Let $e$ be the common Difference, $\infty \times n$ the laſt, and $y$ the Sum of all the Terms of the Progreſſion ſought; then $y = \infty^2 \times \frac{nn}{2e}$: by *Prop.* 2. of § 1. Now becauſe $z = \infty^2 \times \frac{1}{2x}$ is the Sum of the given Progreſſion, therefore from the condition of the Problem $\frac{1}{2x} = \frac{nn}{2e}$, ſo $e = xnn$; you may take $n$ at Pleaſure, and ſo you have $e$ and conſequently the Progreſſion ſought.

*Exemp.* 1. Let the given Progreſſion be 1, 2, 3, 4, 5, *&c.* to $\infty \times 1$. where $x = 1$, ſo $e = nn$; calling $n = 2$, you have $e = 4$ for the common Difference of the Progreſſion ſought, *viz.* 1, 5, 9, 13, *&c.* to $\infty \times 2$. I ſay then that the Sums of theſe two Progreſſions are equal.

*Corol.* $n = \sqrt{\frac{e}{x}}$, ſo taking $e$ at Pleaſure, you have $n$, as in the former Example, if you call $e$,

2, then $n = \sqrt{2}$, so the Progression sought is, 1, 3, 5, 7, &c. to $\infty \times \sqrt{2}$, whose Sum shall be equal to $1 + 2 + 3 + 5 + 6$ &c. to $\infty \times 1$. So that in solving this Problem, you may either make the common Difference, or the infinitely small part ($n$) of the last Term, what you please; and because one of the two may be taken at Pleasure, therefore the Problem is indetermined, and consequently you may find as many Progressions as you please, whose Sums shall each of them be equal to the Sum of the given Progression.

*Scholium.* In the same manner you may find as many Progressions as you please, the Sum of each of which shall be to the Sum of the given one in any given Ratio of $k$ to $h$; for then $\frac{nn}{2e}$; $\frac{1}{2x} :: k : h$, which gives $ke = hxn^2$; so that of these two ($e, n$) taking one at Pleasure, you have the other from this Equation.

*Problem* 2. Having the Sum $\infty^2 \times q$ of any Progression, to find another that shall have a given common Difference $e$, and whose Sum shall be equal to the given Sum. Let $\infty \times n$ be the last Term of the Progression sought, then its Sum will be $= \infty^2 \times \frac{n^2}{2e}$; therefore by the condition of the Problem $\frac{n^2}{2e} = q$. so that $n = \sqrt{2eq}$;

$\sqrt{2eq}$ : but, $e$ and $q$ are given, therefore $n$ is known.

*Examp.* Let $q = 1$, it is requir'd to find a Progreſſion whoſe Difference ſhall be 1, and its Sum $= \infty^2 \times 1$ or the Square of infinite; now becauſe $q = 1$, and $e = 1$, therefore $n = \sqrt{2}$, ſo that $\infty \times \sqrt{2}$ ſhall be the laſt Term of a Progreſſion 1, 2, 3, 4, 5, 6, 7, *&c.* whoſe Sum ſhall be $= \infty^2$; but by *Examp.* 2*d.* of *Prop.* 1. of § 1. if $x = \frac{1}{2}$, and $v = \infty$, then the Sum $z = \infty^2$; *Ergo* $1 + 2 + 3 + 4 + 5$ *&c.* to $\infty \times \sqrt{2} = 1 + 1\frac{1}{2} + 2 + 2\frac{1}{2}$ *&c.* to $\infty \times 1$.

*Examp.* 2. Let $q = \frac{1}{2}$, and $e = 2$, then $n = \sqrt{2}$, ſo that a Progreſſion whoſe common Difference is 2, and laſt Term $\infty \times \sqrt{2}$ ſhall have its Sum $= \infty^2 \times \frac{1}{2} =$ (by *ex.* 1. *pr.* 1.) $1 + 2 + 3 + 4 + 5$ *&c.* to $\infty$.

§ V. *Lemma* $\frac{1}{1 - r}\overline{|}\, e = 1 + er + \frac{e \times \overline{e+1}}{2} \times r^2 + \frac{e \times \overline{e+1} \times \overline{e+2}}{2 \times 3} \times r^3 + \frac{e \times \overline{e+1} \times \overline{e+2}}{2 \times 3} \times \overline{e+3} \times r^4 + \frac{e \times \overline{e+1} \times \overline{e+2} \times \overline{e+3} \times \overline{e+4}}{2 \times 3 \times 4 \times 5} \times r^5$ *&c.*

Let us now conſider the various Progreſſions that will ariſe out of this Series, and what relation they have to infinite in general or $\infty \times 1$, and that I may proceed diſtinctly, I will reſolve it into ſeveral Caſes, beginning at the Simpleſt, where $r = 1$, and ſo proceed gradually to $r = 2$

$r = 3$

$r = 3$, *&c.* And where the Series is neither in an Arithmetical nor yet in a Geometrical Progression, I shall endeavour to discover according to what increase the Progression goes on; tho' in general that is plain enough from the *Lemma* of § 5.

Case 1. Let $r = 1$, which contains an infinite number of other Cases, according to the Different values of $e$, the Progression whereof I shall show in the following Articles.

*Artic.* 1. $(e = 1.) \frac{1}{1-1} = 1 + 1 + 1 + 1$ *&c.* $= \infty \times 1$.

*Artic.* 2. $(e = 2) \frac{1}{1-1|}2 = 1 + 2 + 3 + 4$, *&c.* $= \infty^2$

*Artic.* 3. $(e = 3) \frac{1}{2-1|}3 = 1 + 3 + 6 + 10$ *&c.* $= \infty^3$

*Artic.* 4. $(e = 4) \frac{1}{1-1|}4 = 1 + 4 + 10 + 20$ *&c.* $= \infty^4$

Now you are to observe that the Terms of any one of these Progressions is made up the of Sum of the Terms of the Progression next preceeding; for instance, the third Term of the Progression $\infty^3$, *viz.* 6, is the Sum of the three first Terms of the Progress $= \infty^2$; in like manner the fourth Term (20) of Progression in Article fourth, is the Sum of the

the four first Terms in the Progression of *Art.* 3*d.* and the *7th* Term of *Art.* 3*d.* is the Sum of the Seven first Terms in *Art.* 2*d.* It is to be observed likewise that the Terms of *Art.* 3*d.* are *Triangular Numbers*, since they are the Sums of the Natural Numbers of *Art.* 2*d.* and consequently the Sum of the *Triangular* Progression continued in *infinitum*, is equal to the *Cube* of Infinite. *Case* 2*d.* $r = 2$.

*Art.* 1. $e = 1$, then $\frac{1}{1-2} = 1 + 2 + 4 + 8$, *&c.* $= \infty \times 2$.

*Art.* 2. $e = 2$, then $\frac{1}{1-2|}2 = 1 + 4 + 12 + 32$, *&c.* $= \infty^2 \times 4$.

*Art.* 3. $e = 3$, then $\frac{1}{1-2|}3 = 1 + 6 + 24 + 80$, *&c.* $= \infty^3 \times 8$.

*Art.* 4. $e = 4$, then $\frac{1}{1-2|}4 = 1 + 8 + 40 + 160$, *&c.* $= \infty^4 \times 16$.

*Note*, that the Terms of *Art.* 1*st.* are in a Geometrical Progression in the Ratio of 1 to 2.

And it is observable that the terms of any following *Article* is made by the multiplication of the Terms of *Art.* 1st. into the respective Terms of that *Article* in *Case* 1. where *e* has the same Value. For instance the third Term of *Article* 2, is the Product of the third Term of *Artic.*

1. into the third Term of *Artic.* 2. of *Case* 1. and the fourth Term (*viz.* 160) is the Product of the fourth Term (*viz.* 8.) of *Artic.* 2. into the 4*th* Term (*viz.* 20) of *Artic.* 4*th. Case* 1st. And universally, let *A* denote any Term in any *Artic.* of *Case* 1. *B* any Term in *Artic.* 1*st* of *Case* 2*d.* And *C* any Term in any of the following *Articles* of *Case* 2*d* ; I say $C = AB$, taking *A B C* in the same order *i. e.* if *C* be the 5*th* Term, then *A* and *B* must also be the 5*th* Terms of their Progressions, and whatever Value (*e*) has in the Progression of which *C* is the Term, it must have the same in that Progression where *A* is the Term: *Examp.* To find the 7*th* Term of *Artic.* 3. of *Case* 2. Here *C* denotes the 7*th* Term of a Progression in which $e = 3$ : this shews that *A* is the 7*th* Term of *Artic.* 3. *Case* 1*st*, which multiplied into the 7*th* Term *B* of *Artic.* 1. *Case* 2*d* will give *C* the Term sought.

*Case* 3*d.* $r = 3$

*Art.* 1. $e = 1$, then $\frac{1}{1-3} = 1 + 3 + 9 + 27$ *&c.* $= \infty \times \frac{3}{2}$.

*Art.* 2. $e = 2$, then $\frac{1}{1-3}\Big|^2 = 1 + 6 + 27 + 108$, *&c.* $= \infty^2 \times \frac{2}{4}$.

*Art.* 3. $e = 3$, then $\frac{1}{1-3}\Big|^3 = 1 + 9 + 54 + 270$, *&c.* $= \infty^3 \times \frac{27}{8}$.

*Art.*

*Art.* 4. $e=4$, then $\frac{1}{1-3|4} = 1+12+90+540$, *&c.* $= \infty^4 \times \frac{81}{16}$.

*Note*, the first Series is a geometrical Progression going on in the Ratio of 1 to 3. And the following Progressions are made out of this first, with the respective ones of those in *Case* 1*st* in all respects, as those of *Case* 2*d* already explain'd: for let *A* be any Term in any *Artic.* of *Case* 1. *B* a Term of the same order (with *A*) in *Artic.* 1. *Case* 3. and *C* a Term of the same order in any of the *Articles* of *Case* 3*d*. I say $C=AB$, where *e* has the same Value in *A* that it has in *C*. And so it is for all the succeeding Cases *in infinitum*: The first Series of any case, *r* (*viz.* where $e=1$) is always a geometrical Progression in the Ratio of 1 to *r*; the following Progressions are made by the Multiplication of the Terms of this first Series into the respective Terms of those in *Case* 1. As has been shewn in *Case* 1 and 2*d*.

*Scholium.* To have the first Progression of every *Case*, let $e=1$, then $\frac{1}{1-r} = 1+r+r^2+r^3+r^4+r^5$ *&c.*

But $1+r+r^2+r^3+r^4$ *&c.* $= \infty \times \frac{1}{r-1} = \frac{r}{r-1} + \frac{r}{r-1} + \frac{r}{r-1} + \frac{r}{r-1}$ *&c.*

Before I conclude this Subject, it will be necessary to remove a very obvious and material Objection, *viz.* how it comes to pass that the Sum of the natural Numbers $1 + 2 + 3 + 4 + 5$, *&c.* should be equal to $\frac{\infty^2}{2}$ or half the Square of Infinite, as it appears by *Ex.* 1. of *Prop.* 1. of § 1. And yet the same Sum is $= \infty^2$ or the whole Square of infinite, as appears by *Art.* 2*d.* of Case 1. of the last *Lemma.* This seeming contradiction may be reconciled, if we suppose $\infty \times 1$ to be the last Term in the Progression of *ex.* 1. *prop.* 1. § 1. which will make the Sum $\frac{\infty^2}{2}$; and $\infty \times \sqrt{2}$ to be the last Term in the Progression of *Art.* 2*d.* of Case 1. of the last *Lemma*; for that will make the Sum of the Progression $= \infty^2$, as appears by *ex.* 1. of *prob.* 2. § 3. So that tho' it be the same Progression going on in *infinitum,* yet the one goes on to a greater Infinite, *viz.* $\infty \times \sqrt{2}$ than the other which ends at $\infty \times 1$.

But the plain way of reconciling the Matter depends on the common Rules of Multiplication. For $1 + 2 + 3 + 4 + 5$ *&c.* $= \frac{1}{1-1}2 = \frac{1}{1-1} \times \frac{1}{1-1}$, but $\frac{1}{1-1} = 1 + 1 + 1 + 1$ *&c.* and therefore $1 + 2 + 3 + 4 + 5$ *&c.* $= \overline{1 + 1 + 1 + 1}$ *&c.* $\times \overline{1 + 1 + 1 + 1 + 1}$ *&c.*

Let

Let us now make an actual Multiplication of ſix Terms only, thus

1 + 1 + 1 + 1 + 1 + 1
1 + 1 + 1 + 1 + 1 + 1

*A*. 1 + 1 + 1 + 1 + 1 + 1 *B*.
1 + 1 + 1 + 1 + 1 + 1
1 + 1 + 1 + 1 + 1 + 1
1 + 1 + 1 + 1 + 1 + 1
1 + 1 + 1 + 1 + 1 + 1
*C*. 1 + 1 + 1 + 1 + 1 + 1 *D*

1 + 2 + 3 + 4 + 5 + 6 + 5 + 4 + 3 + 2 + 1

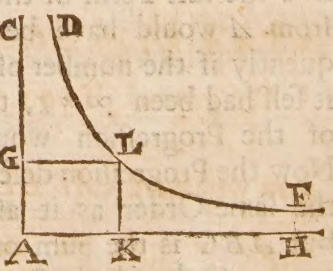
From the Proceſs it is evident, that adding the ſeveral Columns, their Sums make 1, 2, 3, 4, 5, 6. which is the greateſt, *viz*. *B C* (from which they deſcend in the ſame order to *D*) and this *B C* is always the number of Units in each Factor, ſo that if the number of Units multiplied into it ſelf, had been 1000, then *B C* the laſt Term of the Progreſſion aſcending from *A* would have been 1000; and conſequently if the number of Units multiplied into it ſelf had been $\infty \times 1$, then *B C* the laſt Term of the Progreſſion would have been $\infty \times 1$. Now the Progreſſion deſcends from *B C* to *D* in the ſame Order as it aſcends from *A* to *B C*; But *A B C* is the Sum of the Progreſſion 1, 2, 3, 4, 5, 6, *&c*. ending at $BC = \infty \times 1$; and

this Sum $ABC$ is but half the Product (of which $BCD$ is the other) that is to say, half the Square of Infinite: Thus you see that the Process of *Art.* 2. of Case 1. agrees exactly with that of *Prop.* 1. of § 1. only that of *Art.* 2. Case 1. gives you the Progression twice over, and so makes it double of what it is in *Ex.* 1. *Prop.* 1. § 1.

*Schol.* From this Solution it appears that the Sum of the Progression in *Art.* 3. Case 1. *viz.* $1+2+3+6+10+21$ *&c.* is not precisely $\infty^3$ or the Cube of Infinite; for $\frac{1}{1-1} \times \frac{1}{1-1} \times \frac{1}{1-1} = \overline{1+1+1+1}$ *&c.* $\times \overline{1+1+1+}$ $\overline{1}$ *&c.* $\times \overline{1+1+1+1}$ *&c.* contains that Progression oftner than once; and the same is to be considered in all the Progressions, except when $e=1$.

§ VI. The Arithmetick of Infinites applied to Quadratures of Curvilinear Spaces.

Let $DLF$ be any of the Hyperbola's, whose Asymptots are $AC$, $AH$, let $AK=x$, $KL=y$, and the Equation comprehending all the Hyperbola's $y^n x^n = 1$.




By

By the common Methods $CAKLD = \frac{1}{1-n} \times x^{1-n}$

And also $HAGLF = \frac{n}{n-1} \times x^{1-n}$

*Corol.* 1. Let $x = 1$, then $CAKLD = \frac{1}{1-n}$, and $HAGLF = \frac{n}{n-1}$

*Case* 1. Let $n = 1$, so the Equation will be $yx = 1$ for the common Hyperbola, in which $CAKLD = \frac{1}{1-1} = 1 + 1 + 1$, *&c.* $= \infty \times 1$.

And likewise $HAGLF = \frac{1}{1-1} = 1 + 1 + 1 + 1$, *&c.* $= \infty \times 1$. From whence it appears that the Area of the *Apollonian* Hyperbola is infinite both ways.

*Case* 2. Let $n = 2$; so $yx^2 = 1$ defines the next Hyperbola in which $CAKLD = \frac{1}{1-2} = 1 + 2 + 4 + 8 + 16$, *&c.* $= \infty \times 2$.

*Case general.* If you resolve $\frac{1}{1-n}$ into a Series, you will have $CAKLD = \frac{1}{1-n} = 1 + n + n^2 + n^3 + n^4 + n^5$, *&c.* and because the Terms of this Series are in a geometrical Progression ascending

cending (suppoſing $n \angle 1$) in the Ratio of 1 to $n$, therefore by *Prop.* 2. §. 2. the Sum thereof muſt be $1 + n + n^2 + n^3 + n^4 + n^5$, &c. $= \infty \times \frac{n}{n-1}$

Now becauſe $n \angle 1$, therefore $\frac{n}{n-1}$ is $\angle$ 1; therefore in all theſe Hyperbola's (in which $n \angle 1$) the Area $CAKLD$ will be an infinite Number of equal Parts, each of which (*viz.* $\frac{n}{n-1}$) is greater than 1. And hence is underſtood the meaning of the Geometers, who call theſe Spaces greater than infinite, that is greater than $\infty \times 1$ or infinite in general.

*Corol.* 2. In all the Hyperbola's (except the *Apollonian*) the Infinite Area $CAKLD$ (adjacent to the Aſymptote $AC$) is equal to an infinite Number of the finite Area $HAGLF$ (adjacent to the Aſymptote $AH$) in the ſame Hyperbola.

*Demonſtration.* $CAKLD = \infty \times \frac{n}{n-1}$ by the general Caſe, but $HAGLF = \frac{n}{n-1}$ by *Corol.* 1. § 6. Therefore

$\{CAKLD = \infty \times HAGLF\}$ *Q. E. D.*

*Problem.* Let $\infty \times e$ be the infinite Area $CAKLD$ of any given Hyperbola, it is required to find another Hyperbola, whoſe infinite Space

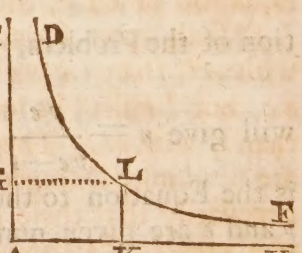
ſhall

ſhall be to the Space ($\infty \times e$) of the given Hyperbola in any given Ratio, as of $p$ to 1. *Sol.* Let $y x^n = 1$. be the Equation of the Hyperbola ſought, then by the general Caſe foregoing its Area is $= \infty \times \frac{n}{n-1}$; therefore by the condition of the Problem, $\frac{n}{n-1}. e :: p. 1$; which will give $n = \frac{pe}{pe-1}$; ſo that $y \overline{x|}^{\frac{pe}{pe-1}} = 1$ is the Equation to the Hyperbola ſought; but $p$ and $e$ are given numbers, and therefore this is a known Equation, and conſequently the Hyperbola defined by it is alſo known.

*Examp.* To find an Hyperbola whoſe Area ſhall be to that of the Apollonian, as 3 to 1. Now the Apollonian is $= \infty \times 1$, ſo $e = 1$, and $p = 3$, *Ergo* the Equation is $y x^{\frac{3}{2}} = 1$, whoſe Area by the general Caſe foregoing is $= \infty \times 3$, which is triple of the Apollonian.

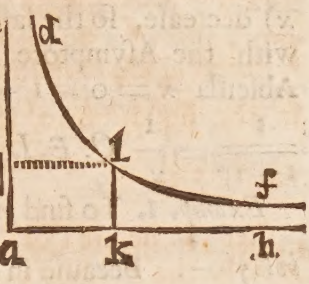
*Prob.* 2. To find an Hyperbola, whoſe interminated Space $HKLF$ ſhall be equal to any given number ($a$) let $y x^n = 1$ define the Hyperbola ſought, where $n > 1$, then $HAGLF = \frac{n}{n-1}$ putting $y = 1$ ($= GL = GA.$) by *Corol.* of § 6. and becauſe $AGLK = 1$, therefore it will be $HAGLF - AGLK (= HKLE) = \frac{n}{n-1} - 1$. Therefore by the condition of the Pro-

Problem $\frac{n}{n-1} - 1 = a$. which gives $n = \frac{a+1}{a}$ so the Equation to the Hyperbola sought is $\overline{yx}^{\frac{a+1}{a}} = 1$.




Let (as before) $AC$, $AH$ be the Asymptotes of any Hyperbola $DLF$ defined by this Equation $yx^n = 1$, in which the Abscissa $AK = x$, and Ordinate $KL = y$, and $n$ is suppos'd either equal to, or greater than Unity. 1° It appears that in all Hyperbola's the interminate Space $CAKLD$ is infinite, and the interminate Space $HAGLF$ (except in the *Apollonian* where $n = 1$) is finite. 2°. In every Hyperbola, one part of it continually approaches nearer and nearer to the Asymptote $AC$, and the other part continually nearer to the other Asymptote $AH$; that is, $LD$ meets with $AC$ at a Point infinitely distant from $A$, and $LF$ meets with $AH$ at a Point infinitely distant from $A$.

3°.




3°. In two different Hyperbola's *DLF*, *dlf*, if we ſuppoſe *n* to be greater in the Equation of *dlf* than it is in the Equation of *DLF*, then *LD* ſhall meet ſooner with *AC* than *ld* with *ac*, but *LF* ſhall be longer in meeting with *AH* than *lf* with *ah*. Therefore ſince theſe meetings are at infinite Diſtance from *A* and *a*, it follows neceſſarily that theſe infinite Diſtances muſt be one greater than another, *viz.* *ac* ∠ *AC*, and *ah* ⊐ *AH*; and in the ſame Hyperbola *AC* ∠ *AH* and *ac* ∠ *ah*, except the *Apollonian* in which *AC* = *AH*.

Therefore it muſt needs contribute very much to the right underſtanding the Scope of the foregoing Quadratures of theſe interminate hyperbolick Spaces, if we can determine the Length between the Centre *A* or *a* and the Point of concourſe of either Part of the Hyperbola, with that Aſymptote to which it approaches.

*Problem* 3. To find the Point *C* where *LD* meets with the Aſymptote *AC*, and the Point *H* where *LF* meets with the Aſymptote *AH*, for any Hyperbola *DLF*, whoſe Equation $y x^n = 1$ is given.

*Solution.* It is evident that the Ordinates *LK* $(= y = \frac{1}{x^n})$ increaſe as the Abſciſſa's *AK* (= *x*)

$x$) decreaſe, ſo the laſt Ordinate muſt co-incide with the Aſymptote $AC$, in which Caſe the Abſciſſa $x = 0 = 1 - 1$. Therefore $AC = \frac{1}{1-1|^n} = \frac{1}{x_n}$ *Q. E. I.*

*Examp.* 1. To find $AC$ in the common *Hyperbola* $= \frac{1}{x}$. Becauſe in this $n = 1$, therefore $AC = \frac{1}{1-1} =$ (by *Art.* 1. of § 5) $1 + 1 + 1 + 1$, *&c.* $= \infty \times 1$.

*Examp.* 2. To find $AC$ in the Hyperbola whoſe Equation is $y = \frac{1}{x^2}$. Becauſe in this $n = 2$, therefore from the general Solution $AC = \frac{1}{1-1|}2 = 1 + 2 + 3 + 4 + 5 + 6$, *&c.* $= \frac{\infty^2}{2}$; That is, $AC$ is an infinite Number of equal Parts, each of which is $\infty \frac{1}{2}$: So that $AC$ in this is an infinite Number of equal Parts, each of which is $\frac{1}{2}$ $AC$ in the common Hyperbola.

*Schol.* If we could give the Preciſe Sum of the Series in *Art.* 3, 4, *&c.* of *Caſe* 1. of § 5. we ſhould then have $AC$ for all the other Hyperbola's; but that is not eaſily to be done, as is declared in the Scholium at the End of § 5. Only

ly this much we see (by *Case* 4. of § 5.) That $AC$ increases as the Powers of $\infty$ whose Exponents are $n$. So in the Hyperbola $y = \frac{1}{x}$, $AC$ is as $\infty$; In the Hyperbola $y = \frac{1}{x^2}$, $AC$ is as $\infty^2$; in the Hyperbola $y = \frac{1}{x^3}$, $AC$ is $\infty^3$; and so on

*Part.* 2*d.* To find $AH$ when $LF$ meets with its Asymptote $AH$. Here we must consider $GL$ $(= x)$ as the Ordinate, and $AG$ $(= y)$ as the Abscissa. Now when $GL$ becomes $AH$, then $y = 0$. But universally $GL\ (= x) = \frac{1}{y|\frac{1}{n}}$

therefore $AH = \frac{1}{0|\frac{1}{n}} = \frac{1}{1-1|\frac{1}{n}}$; put $\frac{1}{n} = e$,

and then by *Lem.* of § 5. $AH = \frac{1}{1-1|} e = 1 + e + \frac{e \times e+1}{2} + \frac{e \times e+1 \times e+2}{2 \times 3} + \frac{e \times e+1 \times e+2 \times e+3}{2 \times 3 \times 4}$, *&c.*

But since we cannot assign the Sum of these Progressions, therefore this Series is of no use in the Solution of the Problem. We shall therefore consider rhe Problem (as to the finding $AH$) under two Cases, first when $n$ is an Integer, and secondly when it is a Fraction.

*Case*

*Case* 1. When $n$ is an Integer. So if $n = 1$ (as in the common Hyperbola) then $AH (= \frac{1}{1-1} = 1 + 1 + 1$, &c. $= \infty \times 1 = AC$. If $n = 2$, then $AH (= \frac{1}{1-1|^{\frac{1}{2}}} = \sqrt{\frac{1}{1-1}} = \sqrt{\infty \times 1})$ is a mean Proportional between 1 and Infinite. If $n = 3$, then $AH (= \frac{1}{1-1|^{\frac{1}{3}}} = \sqrt[3]{\frac{1}{1-1}} = \sqrt[3]{\infty \times 1}$ is the first of two mean Proportionats between 1 and Infinite. And universally if between 1 and Infinite there be supposed as many mean Proportionals as there are Units in $n - 1$, then $AH (= \frac{1}{1-1|^{\frac{1}{n}}} = \sqrt[n]{\frac{1}{1-1}} = \sqrt[n]{\infty \times 1})$ shall be the first of these Means.

*Case* 2*d*. When $n$ is a Fraction, suppose $n = \frac{p}{q}$, but $p < q$, because we always suppose $n < 1$ except in the *Apollonian* where $n = 1$. So then $\frac{1}{n} = \frac{q}{p}$, therefore $AH = \frac{1}{1-1|^{\frac{p}{q}}} = \sqrt[p]{\frac{1}{1-1}}^q = \infty \times 1|^{\frac{q}{p}} = \sqrt[p]{\infty \times 1}^q$. So for *ex.* if $n = \frac{3}{2}$, *viz.* $p = 3$, $q = 2$, then $AH = \sqrt[3]{\infty \times 1|^2}$

*Corol.*

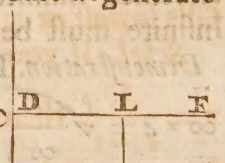
*Corol.* From both these Cases it is evident, that the greater number we suppose $n$ to be, so much the sooner will $L\,F$ meet with $A\,H$: for the greater we suppose $n$ to be, so much the less will $\frac{1}{n}$ or $(\frac{q}{p})$ be; but $\frac{1}{n}$ ($\frac{q}{p}$) is the exponent of $\frac{1}{1-1}$ ($\infty$) which gives the Value of $A\,H$. *Ergo* the greater that $n$ is, the shorter will $A\,H$ be. *Q. E. D.*

*Schol.* Since in all Hyperbola's $A\,H = \frac{1}{1-1^{\frac{1}{n}}} = \frac{1}{1-1^{\frac{q}{p}}} = \sqrt[p]{\frac{1}{1-1}^{q}} = \sqrt[p]{\infty \times 1^{q}}$ is some mean Proportional between 1 and $\infty \times 1$, it is worth the while to consider what sort of Numbers these means are, *viz.* whether they be finite, infinite, or neither. It is certain they cannot be finite, for then it would follow that the Square of a finite number should be infinite, which is absurd. Nor can they be properly esteemed Infinite, for the equal part of such an Infinite must be 1 divided by such a mean.

*Demonstration.* Let $a$ denote that equal part, then $\infty \times a = \sqrt[p]{\infty\,1^{q}}$, which gives $a = \frac{1}{\sqrt[p]{\infty}^{p-q}}$ *Q. E. D. Ex. gra.* $\sqrt{\infty \times 1}$ or a mean between 1 and infinite must be $\infty \times \frac{1}{\sqrt{\infty}}$ or an infinite Num-

Number of equal Parts, each of which is $\frac{1}{\sqrt{\infty}}$ or 1 divided by the mean between 1 and $\infty \times 1$. So that this equal part $\frac{1}{\sqrt{\infty \times 1}}$ is neither finite, nor infinitely small, nor infinitely great, and consequently the mean $\sqrt{\infty \times 1}$ is not properly an infinite Number. And hence we see that there are Progressions of Numbers whose Sums are neither finite nor infinite, but between both. *Ex. gra.* $\sqrt{\infty \times 1}$ where $p = 2, q = 1$, so $\sqrt{\infty \times 1}$ $\frac{1}{1 - \frac{1}{2}|} \frac{1}{2} = 1 + \frac{1}{2} + \frac{3}{8} + \frac{5}{16} + \frac{35}{128}$ &c. is a Number neither finite nor infinite: and so all the means between 1 and Infinite, are neither finite nor infinite.

I have hitherto considered only these Cases in in which $n =$ or $< 1$; let us now see what would be the Result if we suppose $n = 0$. It is evident then that the general Equation, *viz.* $yx^n = 1$ to all Hyperbola's would, in, this Case be $y = 1$, so that the Hyperbola's will in this Case degenerate into a strait Line $D L F$, parallel to $A H$. But considering it as the simplest Hyperbola, let us consider at what distance it will meet with its Asymptotes. Now universally $AC = \frac{1}{x|}^n$ (by the *Sol*




when

of part. 1. of *Prob.* 3.) when $x = 0$, but $n = 0$ by Suppoſition: *Ergo*, be $x$, what it will $x^0 = 1$, *Ergo*, $AC = 1$, 2°. From the Solution of part 2. of *Prob.* 3. we have found that $AH = \frac{1}{1-1|\frac{1}{n}}$ which in this Caſe will give $AH = \frac{1}{1-1|\frac{1}{0}} = \frac{1}{1-1|\frac{1}{1-1}}$, that is $AH = \overline{\infty}|^{\infty}$ or the infinite Power of infinite.

*Corol.* 1. Conſidering a ſtrait Line as an Hyperbola, it can have but one Aſymptote, *viz.* $AH$, whoſe Concurſe with $AH$ is at greater Diſtance from $A$ than any other Hyperbola whatſoever.

*Corol.* 2. All the Hyperbola's $y x^n = 1$ whoſe Aſymptotes are $AC$, $AH$ muſt interſect $DF$, and the greater $n$ is, ſo much the more they bend towards $AH$ and recede from $DF$. And as they all interſect $DF$, ſo they all interſect one another in one point only; and after the Interſection, that in which $n$ is greateſt, ſtill falls loweſt or approaches neareſt to $AH$.

*Schol.* If you ſuppoſe $n$ infinitely great, *viz.* $n = \frac{1}{1-1}$, then the Hyperbola will be a ſtrait Line parallel to the Aſymptote $AC$.

*Sect.* 7. We have now finiſhed this Buſineſs of the Hyperbola's which has afforded us a new Speculation of Numbers, *viz.* of ſuch as are

neither finite nor infinite, which deserves to be consider'd better than either my Time or my Capacity will permit. However I shall here set down a few thoughts about them, till I have more Leisure to prosecute them.

*First* then, to distinguish them from finite and infinite, I shall call them *indefinite* Numbers, and denote them by this Sign $\propto$.

2°. *Indefinite* Numbers I suppose to be intermediate Numbers lying between finite and infinite: For as we do not descend from 1 to 0 at one Step, but must pass through an infinite Series of Fractions, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, *&c.* So it is impossible that in ascending from 1 to $\infty$, we should pass immediately from finite to infinite; therefore the Steps between these two are indefinite Numbers: thus before we arrive from 1 to $\infty$ 1, we must come at $\surd \infty$ 1, and before we come at $\surd \infty \times 1$ we must first come at $\sqrt[3]{\infty \times 1}$ and so on.

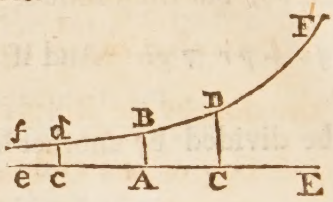
3°. The Rules for the Arithmetick of Indefinites, may be made after the same manner as is done for that of Infinites by D. *Cheyne*. To which I shall add, that an Indefinite as $\infty \frac{q}{p}$ or $\sqrt[p]{\infty^q}$ multiplied by another Indefinite as $\infty \frac{r}{s}$ makes the Product $\infty \frac{q}{p} + \frac{r}{s}$ this Product becomes

comes Infinite when it happens that $qs + pr \angle$ or $= ps$, but the Product is only Indefinite when $qs + pr \rangle ps$. And if an Indefinite as $\overline{\infty}\,|\,\frac{q}{p}$ be divided by another Indefinite as $\overline{\infty}\,\frac{r}{s}$, the Quotient $\overline{\infty}\,|\,\frac{p}{q} - \frac{r}{s}$ is infinite when $qs - pr$ is $\angle$ or $= ps$; but it is finite when $qs - pr = 0$, and indefinite when $qs - pr \rangle ps$.

*Note*, That in expreſſing an Indefinite Number by $\overline{\infty}\,\frac{p}{q}$, I always ſuppoſe the Numerator $q$ leſs than the Denominator $p$; for if $q$ be either $\angle$ or $= p$, then $\overline{\infty}\,|\,\frac{p}{q}$ is an Infinite. That theſe Numbers are not infinite, may be thus demonſtrated. If (*ex. gr.*) $\sqrt{\infty \times 1}$ were infinite, then $\infty \times \frac{1}{\sqrt{\infty}} \left(= \sqrt{\infty \times 1}\right)$ muſt be infinite, and alſo $\frac{1}{\sqrt{\infty}}$ muſt be $= 0$; *Ergo* $\infty \times 0 = \infty \times \frac{1}{\sqrt{\infty}} \left(= \sqrt{\infty}\right)$ = infinite, but $\infty \times 0 = 1$; *Ergo* $1 =$ infinite, which is abſurd.

*Sect.* 8. Containing some miscellaneous things relating to Infinites.

*Lem.* Let $F B D d e$ be a Logarithmick Curve whose first Ordinate $A B = 1$, Abscissa $A C = x$, Ordinate $C D = y$, and Asymptote $E e$:




Now from the known Property of this Curve, it Follows,

1°. That $AC$ are the Logarithms of $C D$, *i. e.* If you make the Ordinate $y = C D$ represent a Number, then its Abscissa $x$ ($= AC$) shall be the Logarithm thereof.

2°. That the Logarithm of 1 is nothing; for the first Ordinate $A B = 1$, but its Abscissa is $= 0$, therefore (by 1°) the Log. of $1 = 0$.

3°. That the Ordinates $c d$ (to the left of $A B$) denoting Fractions, their respective Abscissa's $A c$ are the Logarithms of these Fractions: So that as $x$ is the Log. of any Integer, $C D$, in the like manner $-x$ denotes the Log. of any Fraction ($c d$).

4°. That the Log. of any Fraction $\frac{1}{n}$ is equal to — Log. of $n$. So that the Log. of any Fraction (whose Numerator is 1) is equal in Magnitude to the Log. of that whole Number, which is the Denominator; there being no Difference between the Log. of that Fraction $\frac{1}{n}$ and the Log. of this Integer $n$, but that this is $+x$ (because it lies to the right from $A$ towards $E$)

$E$) and the other $-x$ becauſe it lies to the left from $A$ towards $e$.

*Demonſtration.* $\frac{1}{n}$ ſignifies 1 divided by $n$, therefore by the Rules of Diviſion $l : 1 - l : n =$ Log. of the Quotient, *viz.* $l : \frac{1}{n}$. But $l : 1 = 0$ (by 2°) *Ergo* $-l : n = l : \frac{1}{n}$. *Q. E. D.*

5°. If this Curve be continued (*utrinque*) from $B$ *in infinitum*, then $f$, will meet with the Aſymptote at an infinite Diſtance $A e$: But it will diverge from the Aſymptote on the other ſide, ſo that at an infinite Diſtance $A E$ the laſt Ordinate $E F$ will be infinite. And ſince the laſt Ordinate $e f$ is $= 0$, whoſe Abſciſſa $A e = \infty$, it is evident that the Log. of 0 is $= \infty$ or rather $= -\infty$: It is evident likewiſe the laſt Ordinate $E F$ is $= \infty$, whoſe Abſciſſa $A E$ is alſo $= \infty$. So that the Log of 0 and the Log. of $\infty$ are equal, only the one is $+\infty$ and the other $-\infty$.

*Prop.* 1. $\frac{1}{0} = \infty = 1 + 1 + 1 + 1 + 1$, *&c.*

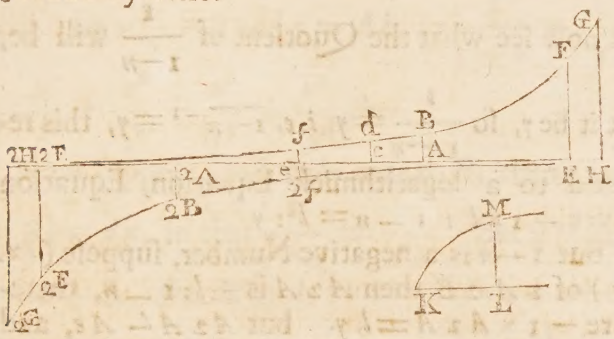
This may ſeem abſurd, but the Demonſtration is evident from the foregoing *Lemma*. For $\frac{1}{1-1} = \frac{1}{0}$. Let then $\frac{1}{1-1} = y$. That is $\overline{1-1}|^{-1} = y$.

This reduc'd to a logarithmical Equation gives $-1 \times l : \overline{1-1} = l : y$; that is $-1 \times l : 0 = l : y$. But $l : 0 = -\infty$ (by *Art.* 5. of the *Lem.*) *Ergo* $-1 \times -\infty\ l : y$, that is $+\infty = l : y$. Therefore $y$ is infinite (*sc.* $y = \infty$) for no Number has an affirmative and infinite Logarithm, except an infinite Number. Since then $y = \infty$, then $\frac{1}{1-1} = \infty$ that is $\frac{1}{0} = \infty$. *Q. E. D.*

*Schol.* But by 0 cannot be understood absolute nothing, for an infinite Number of absolute Nothings cannot make 1: but by 0 is understood an infinitely small part, as in the *calc. diff.* $dx$ is an infinitely small part of $x$, so that $dx$ is as 0 to $x$: not that $dx$ is absolutely nothing, for it is divisible into an infinite Number of Parts, each of which is $ddx$. And therefore the Demonstration, which supposing $f$ and $e$ meeting at an infinite Distance $Ae$, makes the last Ordinate $ef = 0$, implies no more but that $ef = dx$. But then it may be inquir'd what is the Quotient that arises from the Division of 1 by absolute Nothing. I say there is no Quotient because there is no Division: therefore it is a Mistake to say the Quotient is 1 or Unity undivided, which is demonstrably false, neither is the Quotient $= 0$. For properly speaking there is no Quotient, and therefore it is an Error to assign any. In like manner, it is an Error to say that $0 \times a$ makes the Product 0; for properly speaking there

there is no Product It is true, this of Multiplication has no influence upon Practice, but that of Division has.

From hence it appears, that a Curve is said to meet with its Asymptote, when the Ordinate is infinitely little.




This same Notion does explain how it comes to pass that 1 divided by a negative Number, gives a Quotient greater than infinite. For if (when you call $LM = x$, $KL = y$.) $fe = dx$, then because the Points $f$ and $e$ are infinitely near, we may conceive the Logarithmick Curve continued as intersecting $AH$ in the Point $e$; so that $FBf2f2B2F2G$ makes but one continued Curve, whereof the Part above represents the affirmative Numbers by its Ordinates, and the negative Numbers are represented by the Ordinates of the Part below; but $A$ is the Beginning of the Axis for the Logarithms of both, *viz.* $AE$, $AH$, *&c.* are the Logarithms of the affirmative Integers $FE$, $GH$, *&c.* $Ac$ the

Logarithm of any affirmative Fraction, $Ae$ the Logarithm of an infinitely little Fraction $fe = dx$. $A2A$, $A2E$, &c. The Logarithms of the negative Numbers, $2A\ 2B$, $2E\ 2F$, &c.

Now let $n$ be any Number greater than Unity, then $1-n$ will be a negative Number, let us now see what the Quotient of $\frac{1}{1-n}$ will be, let it be $y$, so $\frac{1}{1-n} = y$, *i.e.* $\overline{1-n}|^{-1} = y$, this reduc'd to a logarithmick Equation, Equation gives $-1 \times l : 1-n = l : y$.

But $1-n$ is a negative Number, suppose (*ex. gr.*) of $2A\ 2B$ then $A2A$ is $= l : 1-n$, therefore $-1 \times A2A = l.y$. but $A2A \angle Ae$, and $Ae = -\infty$, therefore $A2A \angle -\infty$. Let then $A2A = -\infty \times a$ (where $a \angle 1$) then $-1 \times -\infty\ a = l : y$, that is $\infty \times a = l : y$, but $\infty \times a \angle \infty$, *Ergo* $y$ is a Number greater than infinite.

And here it is obsevable that there are affirmative Numbers less than nothing, denoted by the several Powers of $dx$, as $dx^2$, $dx^3$, &c. or by the second, third, &c. Differences, and these Numbers may be aptly represented by the Ordinates of the Logarithmick Curve, continued from $f$ towards $2H$ when $dx^n$, is affirmative, or from $2f$ towards $H$ when $dx^n$ is negative.

Another way of explaining what is meant by $\frac{1}{0} = \infty$.

Let

Let $AH$ produced indefinitely be divided into equal

Parts $AB$, $BC$, $CD$, $DE$, &c. ſo that a Part of this Line ſhall denote any Number, ſuppoſing $AB = 1$, let then $x$ denote any Number, ex. gr. let $x = AB$ and $y = Ab$. ſo $\frac{1}{y-x} = \frac{1}{y} + \frac{x}{y^2} + \frac{x^2}{y^3} + \frac{x^3}{y^4} + \frac{x^4}{y^5}$, &c.

Now ſuppoſe $b$ infinitely near to $B$, then $y - x = Bb = dx$, ſo that $\frac{1}{y-x} = \frac{1}{dx}$. But $x = dx + dx + dx$, &c. That is $1 \times x = dx \times 1 + 1 + 1 + 1$, &c. And therefore $\frac{1}{dx} = \frac{1}{x} + \frac{1}{x} + \frac{1}{x} + \frac{1}{x}$, &c. But by Suppoſition $x = AB = 1$. *Ergo* $\frac{1}{dx} = 1 + 1 + 1 + 1$, &c. $= \infty \times 1$

But $\frac{1}{0} = 1 + 1 + 1 + 1$, &c. *Ergo* $\frac{1}{0} = \frac{1}{dx}$, or $dx = 0$, but $dx$ is not abſolute nothing, and therefore when we ſay $\frac{1}{0} = 1 + 1 + 1$, &c. $0$ does not denote abſolute nothing, but only $dx$ or an infinitely ſmall part of $x$. And therefore

fore when (in the Quotient $\frac{1}{y-x}$) we say let $y = x$, the meaning is not that $y$ is absolutely equal to $x$, (for then there would be no Division, and consequently no Quotient) but only that $y$ exceeds $x$ by an infinitely small Quantity $dx$, which is sufficient to make them equal.

I have hitherto considered no Progressions of Numbers except these that are in Arithmetical and Geometrical Progressions, and these that arise from $\frac{1}{1-1}e$ as in § 5. I shall now proceed to treat of other Progressions, and these which offer themselves first are the several powers of Numbers in an Arithmetical Progression. Let then $z$ denote the Sum of any Arithmetical Progression $a$, $a+x$, $a+2x$, $a+3x$, $a+4x$, &c. $A$ the Sum of their Squares, $B$ the Sum of their Cubes, $C$ the Sum of their Biquadrates, &c. that is, let

$z = a + (a+x) + (a+2x) + (a+3x) + (a+4x)$ &c.

$A = a^2 + \overline{a+x}|^2 + \overline{a+2x}|^2 + \overline{a+3x}|^2 + \overline{a+4x}|^2$ &c.

$B = a^3 + \overline{a+x}|^3 + \overline{a+2x}|^3 + \overline{a+3x}|^3 + \overline{a+4x}|^3$ &c.

$C = a^4 + \overline{a+x}|^4 + \overline{a+2x}|^4 + \overline{a+3x}|^4 + \overline{a+4x}|^4$ &c.

And

And ſo on to higher Powers. Now in order to find the Sum of any of theſe Progreſſions aſcending till the laſt Term is $= \infty \times 1$, I ſhall premiſe theſe following *Lemma*'s, by the help whereof you may find $z$, $A, B, C$, *&c.* for any number of Terms. Calling therefore $t$ the number of Terms in each Series, and $v$ the laſt Term of the firſt whoſe Sum is $z$. I ſay

*Lem.* 1. $z = \frac{v^2 + xv + ax - a^2}{2x}$

*Lem.* 2. $A = \frac{\overline{v+x}|^3 - a^3 - tx^3 - 3x^2 z}{3x}$

*Lem.* 3. $B = \frac{\overline{v+x}|^4 - a^4 - tx^4 - 4x^3 z - 6x^2 A}{4x}$

*Lem.* 4. $C = \frac{\overline{v+x}|^5 - a^5 - tx^5 - 5x^4 z - 10x^3 A - 10x^2 B}{5x}$

In each of which $tx = v + x - a$ (by *Lem.* 1. § 1.) and it is eaſy to continue theſe *Lemma*'s for higher Powers.

Before we apply theſe *Lemma*'s to the finding the Sum of any Progreſſion whoſe laſt Term is infinite, it will be neceſſary to ſubſtitute the values of $t$, $z$, $A$, $B$, $C$, *&c.* When you have made this Subſtitution, you muſt reject out of the *Lemma*'s every Term in which $v$ does not occur; for the laſt Term being infinite, will make $v$ an indefinite Number, and ſince all the

other

other Terms (in which $v$ is not) are finite, therefore they are as nothing in respect of $v$ and consequently to be rejected. So, for Progressions whose last Term is $= \infty$, the *Lemma*'s will be

*Lem.* 1. $z = \frac{v^2 + xv}{2x}$

*Lem.* 2. $A = \frac{v^3 - x^2 v}{3x} - \frac{v^2 - xv}{2}$.

*Lem.* 3. $B = \frac{v^4 - 2xv^3 + x^2v^2 + 2x^3 v}{4x}$

*Lem.* 4. $C = \frac{v^5}{5x} + \frac{15v^4 + 10xv^3 - 59x^3 v}{30}$

Let us now consider what the value of $v$ is, in each of the *Lemma*'s $A, B, C, \&c.$ An example or two will make the thing plain.

*Ex.* 1. Let $\left\{ 1, 2, 3, 4, 5, \&c. \text{ to } v, \text{ whose Sum is } z. \right.$

Then for *Lem.* 2. $\left\{ 1, 4, 9, 16, 25, \&c. \text{ to } v^2, \text{ whose Sum is } A. \right.$

But $v^2 = \infty$ (by *Supp.*) Therefore $v = \sqrt{\infty} = \overline{\infty}|^{\frac{1}{2}}$ so that $\infty^{\frac{1}{2}}$ is the value of $v$ in *Lem.* 2*d.* In like manner $\sqrt[3]{\infty}$ or $\infty^{\frac{1}{3}}$ is the value of $v$ in *Lem.* 3. And universally if $e$ denote the Exponent of the Power to which each of the Terms of any Arithmetical Progression are raised, then $v = \sqrt[e]{\infty} = \overline{\infty}|^{\frac{1}{e}}$. in the *Lemma* that gives the Sum of these Terms (whose last is $\infty$) raised to this Power.

*Prop.*

*Prop.* 1. To find the Sum of a Series of Numbers (continued till the laſt Term is $\infty$) whoſe Terms are the Squares of any Arithmetical Progreſſion.

By *Lem.* 2. the Sum ſought is $A = \frac{v^3 - x^2 v}{3x} - \frac{v^2 - xv}{2}$, but in this Caſe $v = \sqrt{\infty}$ or $\infty^{\frac{1}{2}}$, therefore all the Terms except the higheſt muſt evaniſh, and conſequently the Sum of the Squares $A = \frac{v^3}{3x} = \frac{\overline{\infty^{\frac{1}{2}}}^3}{3x} = \frac{\infty^{\frac{3}{2}}}{3x} = \infty \times \frac{\infty^{\frac{1}{2}}}{3x}$,

*Examp.* Let $x$ be $= 1$, ſo $1, 2, 3, 4$, *&c.* to $\sqrt{\infty}$ is the Arithmetical Progreſſion, the Sum ($A$) of whoſe Squares is ſought; I ſay $1 + 4 + 9 + 16$ *&c.* $\infty \times \frac{1}{3}\sqrt{\infty}$ that is, the Sum of the Progreſſion is an infinite Number of equal Parts, each of which is $\frac{1}{3}\sqrt{\infty}$.

*Prop.* 2. To find the Sum of the Cubes of any Arithmetical Progreſſion.

In this Caſe $v = \sqrt[3]{\infty}$ or $\infty^{\frac{1}{3}}$. Therefore in *Lem.* 3*d.* all the Terms except the higheſt muſt evaniſh, ſo that $B = \frac{v^4}{4x} = \frac{1}{4x}\overline{\infty^{\frac{1}{3}}}^4 = \frac{\infty^{\frac{4}{3}}}{4x} = \infty \times \frac{\infty^{\frac{1}{3}}}{4x}$.

Ex.

*Ex.* Let $x = 1$, so $1, 2, 3, 4, 5$, &c. to $\sqrt[3]{\infty}$ is the Arithmetical Progression, the Sum ($B$) of whose Cubes is sought, I say $1 + 8 + 27 + 64 + 125$ &c. $= \infty \times \frac{\infty^{\frac{1}{3}}}{3}$.

*Prop.* 3. To find the Sum of the Biquadrates of any Arithmetical Progression.

In this Case $v = \sqrt[4]{\infty}$ or $\infty^{\frac{1}{4}}$. Therefore by *Lemma* 3*d*. $C = \frac{v^5}{5x} = \frac{1}{5x}\overline{\infty^{\frac{1}{4}}|^5} = \frac{1}{5x}\infty^{\frac{5}{4}} = \infty \times \frac{\infty^{\frac{1}{4}}}{5x}$.

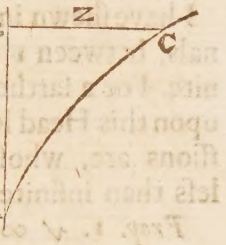
*Ex.* Let $x = 1$, so $1, 2, 3, 4$, &c. to $\sqrt[4]{\infty}$ is the Arithmetical Progression, I say then that $1 + 16 + 82 + 256$ &c. $= \infty \times \frac{\infty^{\frac{1}{5}}}{5}$.

*Prop.* 4. *Universal.* Let $e$ denote the Exponent of any Power, to which the Terms of any Arithmetical Progression $a$. $a + x$, $a + 2x$. $a + 3x$, &c. are raised, and it is required to find the Sum of the Terms so raised. I say

$a^e + \overline{a+x}|^e + \overline{a+2x}|^e + \overline{a+3x}|^e + \overline{a+4x}|^e$ &c. $= \infty \times \frac{\infty^{\frac{1}{e}}}{e+1 \times x}$.

*Scholium.* From hence may be easily deduc'd the Quadratures of all the Parabola's $z = y^e$ (where

where $z$ is the Ordinate, $y$ the Abſciſſa, and $e$ an affirmative Number) which is one remarkable uſe of this Arithmetick of Infinites. For if in this Figure $AB = y$, $BC = 2$, and $z = y^e$ it is plain that if you put $y = 1, 2, 3, 4, 5,$ &c. ſucceſſively, then will $z = 1^e, 2^e, 3^e, 4^e,$ &c ſucceſſively: which ſhews that the Ordinates are the Terms of




an Arithmetical Progreſſion rais'd to a Power, whoſe Exponent is $e$, and that ($x$) the common Difference is 1; But if the firſt Abſciſſa $y = 1$ be infinitely (or indefinitely ſmall) then the Ordinates will be infinitely near to one another, and the laſt Ordinate $BC$ will be an $\infty$ Number of theſe Ones. Therefore ſince to find the Area $ABC$, is, in effect, to find the Sum of the Ordinates, and ſince the Ordinates are $1^e, 2^e, 3^e, 4^e, 5^e,$ &c. till you come to the laſt which is $BC = \infty$. Therefore by Prop. 4. $ABC = \infty \times \frac{\infty^{\frac{1}{e}}}{e+1}$, that is $ABC = BC \times \frac{\overline{BC}^{\frac{1}{e}}}{e+1}$, the ſame which is found by the ordinary Methods of Quadratures. And note that the whole Abſciſſa $AB$ denotes the Number of the Terms.

N. B. *The Quadrature of all ſorts of Curves, expreſs'd by one Term thus aſſign'd, it is eaſy by the Method of Aſſumptions of Series's to extend this Method to all Sorts of Quadratures hitherto diſcovered.*

A D-

## ADDITIONS.

I have shewn in *p.* 160. *&c.* that mean Proportionals, between 1 and ∞ are neither finite nor infinite. For a farther illustration of what I have said upon this Head let us consider what these Progressions are, whose Sum is more than finite and less than infinite.

*Prop.* 1. $\sqrt{\infty}$ is a mean between 1 and infinite; but $\infty = \frac{1}{1-1}$, therefore $\sqrt{\infty} = \frac{1}{\sqrt{1-1}} = \overline{1-1}\Big|^{\frac{1}{2}}$ which by Sir *Isaac Newton*'s Theorem gives

$$\sqrt{\infty} = \overline{1-1}\Big|^{-\frac{1}{2}} = 1 + \tfrac{1}{2} + \frac{1\times 3}{2\times 4} + \frac{1\times 3\times 5}{2\times 4\times 6} + \frac{1\times 3\times 5\times 7}{2\times 4\times 6\times 8}, \text{ \&c. that is } \overline{\sqrt{1+1+1}}, \text{ \&c.}$$

$$= 1 + \tfrac{1}{2} + \frac{1\times 3}{2\times 4} + \frac{1\times 3\times 5}{2\times 4\times 6} + \frac{1\times 3\times 5\times 7}{2\times 4\times 6\times 8}, \text{ \&c.}$$

And so (by squaring each side of this Equation) you will find it in Fact to be $1+1+1$, *&c.* $= 1+1+1$, *&c.* From hence it appears that the Progression, whose Sum (being neither finite nor infinite) is $\sqrt{\infty}$ consists of Fractions whose Numerators are the Products of the continual Multiplication of the Arithmetical Progression

greſſion 1, 1, 3, 5, 7, 9, &c. and the Denominators are the Products of the Multiplications of the Terms of this Arithmetical Progreſſion 2, 4, 6, 8, 10 &c.

*Corol.* In like manner you may find $\sqrt[3]{\infty}$ $\sqrt[5]{\infty}$ &c. by reſolving $\frac{1}{\sqrt[3]{1-1}} = \overline{1-1}|^{-\frac{1}{3}}$ $\frac{1}{\sqrt[5]{1-1}} = \overline{1-1}|^{-\frac{1}{5}}$ &c. into a Series by Sir *Iſaac Newton*'s Theorems. So $\sqrt[3]{\infty} = \frac{1}{\sqrt[3]{1-1}} = \overline{1-1}|^{-\frac{1}{3}} = 1 + \frac{1}{3} + \frac{1 \times 4}{3 \times 6} + \frac{1 \times 4 \times 7}{3 \times 6 \times 9}$ &c. where the Numerators and Denominators are in Arithmetical Progreſſions, whoſe common difference is 3.

$\sqrt[5]{\infty} = \frac{1}{\sqrt[5]{1-1}} = \overline{1-1}|^{-\frac{1}{5}}$ $1 + \frac{1}{5} + \frac{1 \times 6}{5 \times 10} + \frac{1 \times 6 \times 11}{5 \times 10 \times 15}$ &c. $\sqrt[e]{\infty} = \frac{1}{\sqrt[e]{1-1}} = \overline{1-1}|^{-\frac{1}{e}}$

$\frac{1}{e} = 1 + \frac{1}{e} + \frac{1 \times \overline{e+1}}{e \times 2e} + \frac{1 \times \overline{e+1} \times \overline{2e+1}}{e \times 2e \times 3e} + \frac{1 \times \overline{e+1} \times \overline{2e+1} \times \overline{3e+1}}{e \times 2e \times 3e \times 4e} + \frac{1 \times \overline{e+1} \times \overline{2e+1} \times \overline{3e+1} \times \overline{4e+1}}{e \times 2e \times 3e \times 4e \times 5e}$ &c.

*Prop.* 2. Let 1 be the first, $r$ the second, and $v$ the last Term of a Geometrical Progression $1, r, r^2, r^3, r^4$, &c. and $t$ the number of Terms, then $v = r^{t-1} = \frac{r^t}{r}$, which gives $r^t = rv$.

*Corol.* Let $\tau$ be the number of Terms, and $v$ the last Term in the like Progression $1, s, s^2, s^3, s^4$ &c. then $v = s^{\tau-1}$.

*Corol.* 2. From these two Values of $v$, I have this Equation $r^{t-1} = s^{\tau-1}$; whence it appears that if $s$ be greater than $r$, then will $\tau < t$, that is, In any two Progressions whose first Terms are the same, that whose second Term $s$ is greater than $r$ the second Term of the other, will sooner arrive at any given number $v$.

*Example.* Let $r = 2$, then 1, 2, 4, 8, 16. Let $s = 4$, then 1, 4, 16. that is, there are 5 Terms (or $t = 5$) in arriving at 16 in the first Progression, whereas in the second ($\tau = 3$) it arrives at 16 in the 3*d* Term.

*Problem.* Having $r$, $t$, $s$, to find $\tau$ in which they shall both have the same last Term $v$.

*Sol.* $s^{\tau-1} = r^{t-1}$ (by *Corol.* 2.) this turn'd into a logarithmical Equation is $\overline{\tau - 1} \times ls = \overline{t - 1} \times lr$, which reduced gives $\tau = \frac{tlr + ls - lr}{ls} = \frac{tlr - lr}{ls} + 1$. *Q. E. I.*

*Corol.* Because by *Prop.* 2. $r^t = rv$, therefore $tlr = lrv$, so substituting $lrv$ in place of

of $tlr$, we ſhall have $\tau = \frac{lrv - lr + ls}{ls} =$

$\frac{lrv}{ls} - \frac{lr}{ls} + 1.$

*Corol.* 2. Becauſe by *Corol.* 1. $tlr = lrv$, therefore $t = \frac{lrv}{lr}$. And conſequently

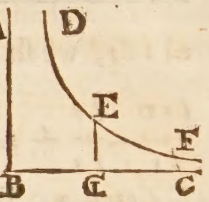
$t - \tau = \frac{lrv}{lr} - \frac{lrv}{ls} + \frac{lr}{ls} - 1.$

But by the known property of Numbers we have $lr + lv = lrv$, therefore $t - \tau = \frac{lr+lv}{lr} - \frac{lr-lv}{ls} + \frac{lr}{ls} - 1$ that is $t - \tau = 1 + \frac{lv}{lr} - \frac{lv}{ls} - 1$, that is,

$t - \tau = \frac{lv}{lr} - \frac{lv}{ls}.$

*Corol.* 3. Let the laſt Term $v$ be infinite or $\infty$, then $t - \tau = \frac{l:\infty}{lr} - \frac{l:\infty}{ls}$; which ſhews how much ſooner the Progreſſion $1, s, s^2, s^3$, *&c.* will arrive at $\infty$, than $1, r, r^2, r^3$, *&c.* that is, how many more Terms there is in $1, r, r^2, r^3$, *&c.* than in $1, s, s^2, s^3$, *&c.* when the laſt in both is $\infty$.

*Prop.* 3. Let $BG = x$ $GE = y$; $y x^s = 1$, where $s$ is any number greater than Unity. Then by the *Calculus Integralis*, we have $DEGBA = \frac{x^{1-s}}{1-s}$, so putting $x = 1$, we have $DEGBA = \frac{1}{1-s}$.




But $\frac{1}{1-s} = 1 + s + s^2 + s^3 + s^4$ &c. $= DEGBA$.

But calling $v$ the last Term of this ascending Geometrical Progression $1 + s + s^2 + s^3 + $ &c. we shall (as is shewn in Page 136. of this Chapter) have $1 + s + s^2 + s^3 + s^4 + $ &c. $= \frac{sv}{s-1}$, therefore $DEGBA = \frac{sv}{s-1}$. So that we have three different expressions of the Area $DEGBA$, *viz.* $\frac{1}{1-s}$, $\frac{sv}{s-1}$, and the Series $1 + s + s^2 + s^3 + s^4$ &c.

But what this number $v$ is (which denotes the last Term of the Progression $1 + s + s^2 + s^3$ &c.) is not so easy to determine; certainly it cannot be $v = \infty \times 1$ or $1 + 1 + 1$ &c. For then

DEGBA

$DEGBA = \infty \times \frac{s}{s-1}$; therefore if in one Hyperbola we put $s = 2$, (*ſcil.* $y x^2 = 1$) we have $DEGBA = \infty \times 2$; and putting in another $1 = 3$ (*ſcil* $y x^3 = 1$) we have $DGEBA = \infty \times \frac{3}{2}$; now this would make the Area of the Hyperbola $y x^2 = 1$ *ſcil.* $\infty \times 2$ greater than the Area of the Hyperbola $y x^3 = 1$ *ſcil.* $\infty \times \frac{3}{2}$ (becauſe $2 \angle \frac{3}{2}$) but it is eaſy to Demonſtrate, that in the Hyperbola's $y x^s = 1$, the greater we ſuppoſe the Exponent $s$, ſo ſhall the Area $DEGBA$ (adjacent to $BG$) be the greater, and conſequently the laſt Term $v$ of the ſeries $1 + s + s^2 + s^3$ *&c.* cannot be $\infty$ or $1 + 1 + 1 + 1 + 1$ *&c.* for upon that value of $v$, the expreſſion $\frac{sv}{s-1}$ would make the Area $DEGBA$ to decreaſe as $s$ did increaſe.

To diſcover the value of $v$, we have $DGEBA = \frac{sv}{s-1} = \frac{1}{1-s}$; which gives $v = \frac{s-1}{s-s^2} = \frac{s-1}{s} \times \frac{1}{1-s} = \frac{1}{-s}$.

Having found $v = \frac{1}{-s}$, we ſee that in two different Hyperbola's (*Ex. gr.* $y x^2 = 1$, and $y x^3 = 1$,) $v$ cannot have the ſame value, for in the former $v = \frac{1}{-2}$, which is leſs then $v = \frac{1}{-3}$, in the other.

*Secondly.* From the value of $v = \frac{s-1}{s} \times \frac{1}{1-s}$ we see that the last Term $v$ is equal to the Sum of the Series (*viz.* $1+s+s^2+s^3$ &c) multiplied upon $\frac{s-1}{s}$ for $\frac{1}{1-s}$ is $= 1+s+s^2+s^3$ &c.

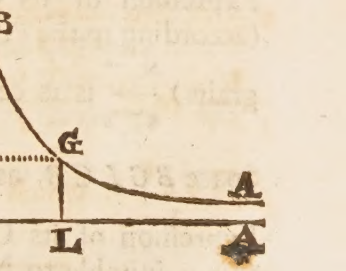
*Corol.* I say the last Term $v$ cannot be $\infty \times n$, take what number you will for $n$ (except in the Case of the common Hyperbola, where $s=1$) For if it were possible, let $v = \infty \times n$; then must $\frac{s-1}{s-s^2} = \infty \times n$, therefore $s-1 = \infty \times ns - ns^2$, which gives $1 = \infty \times \frac{ns-ns^2}{s-1}$, and consequently $\frac{1}{\infty} = \frac{ns-ns^2}{s-1}$, but $\frac{1}{\infty} = 0$, therefore $\frac{ns-ns^2}{s-1} = 0$, which gives $s = 1$. *Q. E. D.*

*Corol.* 2. It is evident that $v$ is some power of $s$, let the Exponent of that Power be $n$, *scil.* $v = s^n$, but $\frac{sv}{s-1} = \frac{1}{1-s}$, therefore $\frac{s \times s^n}{s-1} = \frac{1}{1-s}$, *id est*, $\frac{s^n+1}{s-1} = \frac{1}{1-s}$, therefore $s^{n+1} = \overline{s-1} \times \frac{1}{1-s}$, which reduced to a Logarithmick Equation gives $\overline{n+1} \times l:s = l:\overline{s-1} + l:\frac{1}{1-s}$; which gives $n = \frac{l:\overline{s-1} + l:\frac{1}{1-s}}{l:s} - 1$. *Q E I.*

An

## *An* ANSWER *to Mr.* Varignon's *Reflections upon Spaces greater than infinite.*

LET $BC$, $AC$ making a right Angle at $C$ be the Aſymptotes of any Hyperbola $BGA$; the Abſciſſe $CL = x$, and Ordinate $LG = y$; and the general Equation to all Hyperbola's $y x^e = 1$. Then becauſe $y = \frac{1}{x^e} = x^{-e}$, we have $y\,dx = x^{-e}\,dx$, therefore $\int : y\,dx = \int : x^{-e}\,dx$; but by the Calculus Integralis $\int : x^{-e}\,dx = \frac{x^{1-e}}{1-e}$, therefore $\int : y\,dx = \frac{x^{1-e}}{1-e}$; But $\int : y\,dx = BGLCB$, therefore $\frac{x^{1-e}}{1-e} = BGLCB$;




This Concluſion (though deduced naturally from Principles which Mr. *Varignon* acknowledges to be true) he denies, aſſuring us that it is only the Negative Expreſſion of the Area $AGLA$ or Complement of $BGLCB$, when $e < 1$ But (without any regard to the Ratio of $e$ to 1, let us

us consider the Algebraical Expressions of these two Spaces $BGLCB$ and $AGLA$; we have already found $BGLCB = \frac{x^{-e}}{1-e}$; and calling the Abscisse $CM = y$, and Ordinate $MG = x$, we shall from the Equation $y x^e = 1$, find $ACMGA = \frac{e \times y^{\frac{e-1}{e}}}{e-1}$ but $y^{\frac{e-1}{e}} = x^{1-e}$; therefore $ACMGA = \frac{e \times x^{1-e}}{e-1}$, from which if you substract $CMGL = yx = x^{1-e}$, the Remainder will be (as Mr. *Parignon* says) $AGLA = \frac{x^{1-e}}{e-1}$, which is indeed the Negative of $\frac{x^{1-e}}{1-e}$. But his Conclusion is false and groundless, *viz.* that $\frac{x^{1-e}}{1-e}$ is not the Expression of the Space $BGLCB$, but only (when $e < 1$) the negative Expression of its Complement $AGLA$. For (according to the Principles of the Calculus Integralis) $\frac{x^{-e}}{1-e}$ is as certainly the Expression of the Space $BGLCB$, as its Negative $\frac{x^{-e}}{e-1}$ is the Expression of its Complement $AGLA$. And this is suitable to Natures Proceedings, *viz.* to do things in the simplest and most general Method, and consequently to give one Expression of

of the Area of a Figure and of its Complement, when it can be done. And may it not (with as good reaſon) be ſaid that $\frac{x^{1-e}}{e-1}$ is not the Expreſſion of the Space $AGLA$ but of its Complement $BGLCB$; And not only it may be ſaid, but Mr. *Varignon* muſt ſay ſo in all the innumerable Caſes where $e > 1$; and to ſay it is not when $e < 1$, and it is when $e > 1$; what is this but to ſay backward and forward, according as it will anſwer his Conceit of denying that there are Spaces greater than infinite? But to put this Controverſy beyond all diſpute, let us reſolve theſe two finite Expreſſions of the Spaces $BGLCB$, and $AGLA$, into infinite Series's.

I. $\frac{x^{1-e}}{1-e} = x^{1-e} \times 1 + e + e^2 + e^3 + e^4$, &c. when you begin the Diviſion with 1, as here it naturally ſhould.

II. $\frac{x^{1-e}}{1-e} = x^{1-e} \times -\frac{1}{e} - \frac{1}{e^2} - \frac{1}{e^3} - \frac{1}{e^4}$, &c.

When you begin the Diviſion with $-e$.

III. $\frac{x^{1-e}}{e-1} = x^{1-e} \times \frac{1}{e} + \frac{1}{e^2} + \frac{1}{e^3} + \frac{1}{e^4}$, &c.

When you begin the Diviſion with $e$, as here it naturally ſhould.

IV. $\frac{x^{1-e}}{e-1} = x^{1-e} \times -1 - e - e^2 - e^3 - e^4$, &c.

When you begin the Diviſion with $-1$.

Thus

Thus it appears that each of these two Expressions give two Series, of which the first is the Area directly sought, and the other the negative Expression of its Complement; so

$$\left.\begin{array}{l} BGLCB = \frac{x^{1-e}}{1-e} = x^{1-e} \times 1 + e + e^2 + e^3 + \\ e^4 + \&c. \\ -AGLA = \frac{x^{1-e}}{1-e} = x^{1-e} \times -\frac{1}{e} - \frac{1}{e^2} - \\ \frac{1}{e^3} - \frac{1}{e^4} - \&c. \end{array}\right\}$$

$$AGLA = \frac{x^{1-e}}{e-1} = x^{1-e} \times \frac{1}{e} + \frac{1}{e^2} + \frac{1}{e^3} + \frac{1}{e^4} + \&c.$$

$$-BCLCB = \frac{x^{1-e}}{e-1} = x^{1-e} \times -1 - e - e^2 - e^3 - e^4 - \&c.$$

These are plain and obvious Conclusions deduced from the known and common Operations of Arithmetick, and utterly overthrow all that Mr. *Varignon* alledges against Spaces greater than infinite.

For without any Limitation (except $e < 1$) he says that $\frac{x^{1-e}}{1-e}$ is not the Expression of *BGLCB*, but the Negative of the Space *AGLA*. And if so, then (by Series I.) it will follow

follow that $x^{1-e} \times 1 + e + e^2 + e^3 + e^4$, &c. is the Negative Expreſſion of the Space $AGLA$; and this I ſay implies two manifeſt Abſurdities; (1ſt) That a Sum of affirmative Quantities is Negative, and (2dly) That the Sum of an infinite Geometrical Progreſſion, whoſe Terms are continually increaſing, is equal to a finite Quantity, *i.e.* That Affirmative is Negative, and Infinite is Finite.

That which ſeems to ſhock Mr. *Varignon* is that there ſhould be Spaces greater than infinite, for he tells us expreſly that he looks upon this as a Contradiction. But this difficulty will ſoon evaniſh, if he conſiders what is the ſimple Idea of Infinite; and becauſe he confeſſes that in the *Apollonian* Hyperbola $BGA$, the Space $BGLCB$ is infinite, therefore let us take the Arithmetick value of $BGLCB$ for infinite, but in that Hyperbola $e = 1$, and therefore (if we put likewiſe $x = 1$) we ſhall by Series 1 have $BGLCB = 1 + 1 + 1 + 1 + 1$ &c. that is $BGLCB = \infty \times 1$ or an infinite number of Units. So that when we ſay $2 + 2 + 2 + 2$ &c. or $\infty \times 2$ is more than infinite, no more is meant, but that it is greater then ſimple infinite or $\infty \times 1$; *i.e.* (taking $\infty \times 1$ for the Unit, by which we meaſure Quantities that are infinite) $\infty \times 2 \angle \infty \times 1$, or $2 \angle 1$.

This will be yet plainer in the Caſe of finites. It is certain no Quantity can be leſs than finite

(as

(as none can be greater than infinite) which we shall denote by $\odot \times 1$ or 1; when I say then that $\odot \times \frac{1}{2}$ is less then $\odot \times 1$, I mean no more but that $\frac{1}{2} < 1$; and because I have defined the Idea of finite by $\odot \times 1$ or 1, I may very properly say that $\odot \times \frac{1}{2}$ or $\frac{1}{2}$ is less then a finite Quantity.

*September* 23. 1713.

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